

POLICY MEMORANDUM
OUTENIQUA AND LANGKLOOF MOUNTAINS
SOUTHERN CAPE

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ABSTRACT

The Outeniqua and Langkloof Mountains are islands of fairly pristine mountain fynbos surrounded by intensively cultivated agricultural land, in the Southern Cape. Active management is imperative if the ecosystems are to remain viable. An adaptive system of management is used to determine a management policy for the area. Literature and field surveys supplied data for a basic description of the ecosystems. Management objectives were formulated to realize the following land-use types: water conservation, nature conservation, agricultural utilization, timber production, recreation and research. A Mountain Catchment Area is proposed to realize water conservation aims on private catchment land. An efficient classification system is essential for planning. The study area was subdivided, according to land-use and management objectives, into various management zones: water conservation, restricted management, fire control and nature conservation zones. The basic subdivision of zones are compartments. Fire is central to management and prescribed burning is used to realize management objectives in the zones (e.g. community diversity). A number of specific management tasks are proposed to realize various objectives in each zone.

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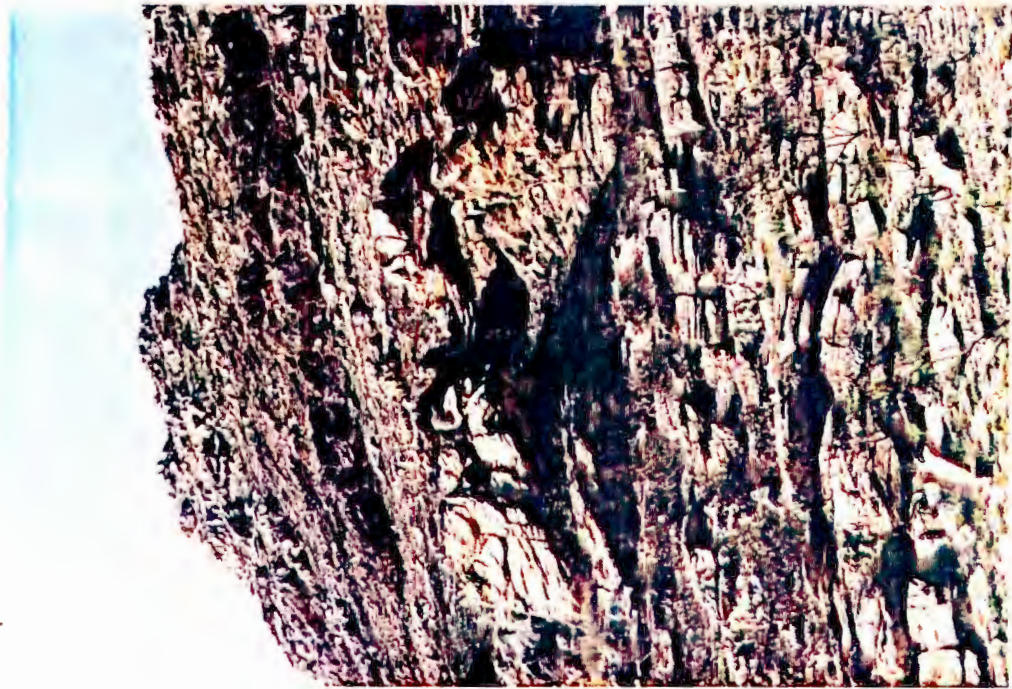


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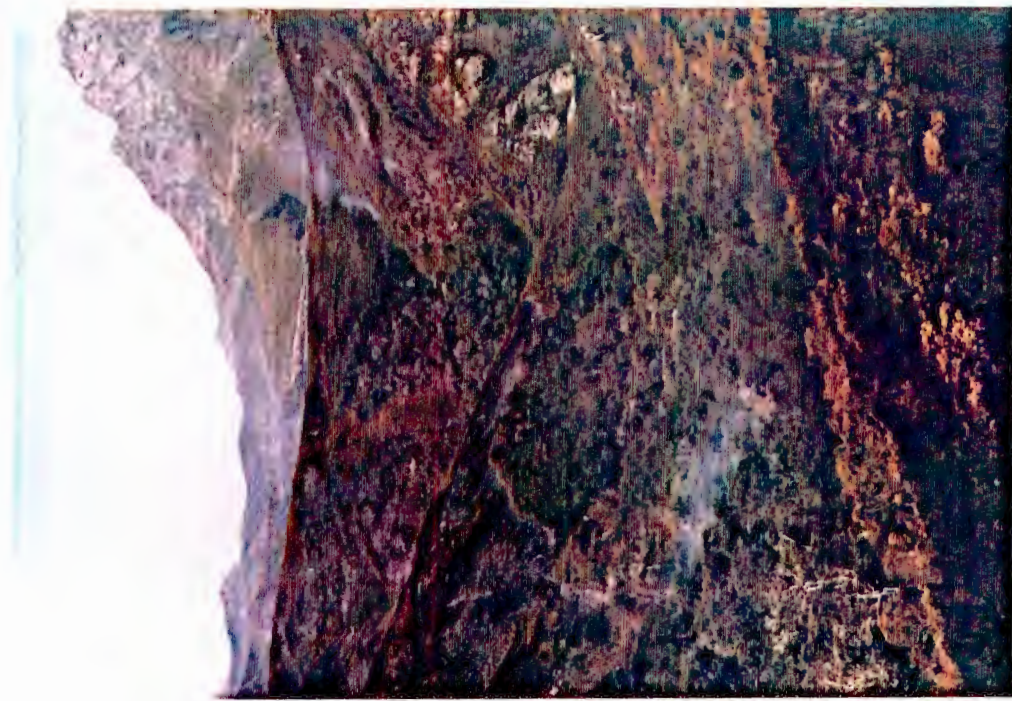


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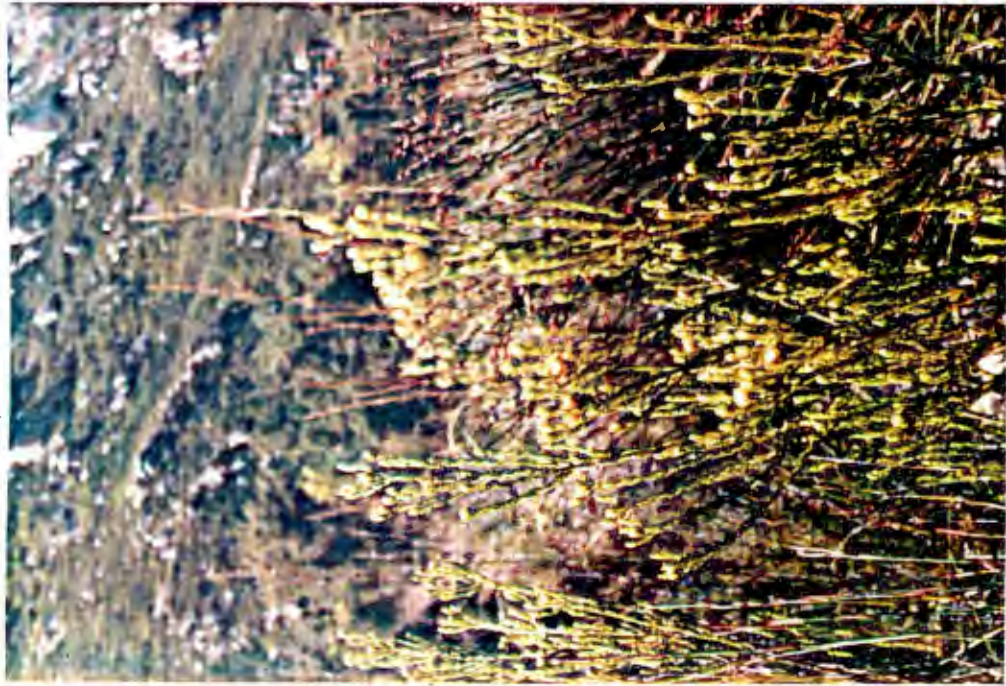


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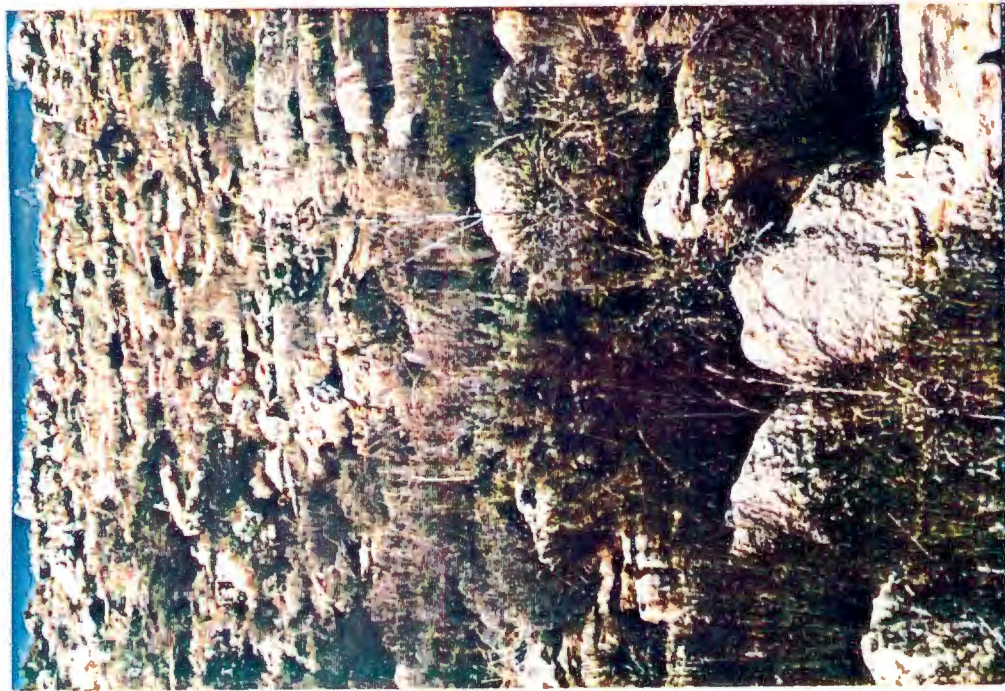


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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

There is an urgent need for an overall management policy for the fynbos catchment areas, on both the southern and the northern slopes of the Outeniqua mountains, Southern Cape. Representative and well-preserved fynbos areas are decreasing due to afforestation, agricultural activities, dam and other construction, *Gleichenia polypodiodes* infestations, short rotation burning for fire protection, and pine and *Hakea* infestation.

Conservation of fynbos would be best served by setting aside large blocks as ecological reserves of Outeniqua fynbos. These areas would be managed specifically for conservation. Fynbos conservation would take second place to plantation management in other areas.

The Department of Environment Affairs is by far the largest single controller of mountain lands, under natural vegetation, in the Republic, and owns approximately 650 000 ha in the Western and Southern Cape, much of it catchment areas (Taylor 1977). Initially a system

of totally protecting fynbos was attempted, and the original management plan for the catchment areas in the Southern Cape prescribed a system where the mountains (Anysberg, Rooiberg, Swartberge, Kammanassieberge, Kougaberge, Baviaanskloof, Groot Winterhoek and the northern slopes of the Outeniqua-Tsitsikamma ranges) were divided into a system of large blocks by fire-breaks and access roads. Fires were restricted between horizontal and vertical breaks to prevent areas larger than 500 - 1000 ha burning at one time. These attempts were mostly unsuccessful. In the history of the Southern and South-western Cape, the practice is somewhat arbitrary and artificial (Kruger 1974).

Research in catchment hydrology (reviewed by Wicht 1945, 1947), the general awareness of amenity (Le Roux 1966; Möhr 1966), research on the ecology, including the influence of vegetation on water (Rycroft 1955; Banks 1962; Malherbe 1968; Plathe and Van der Zel 1969; Wicht 1971b; Van der Zel and Kruger 1975), led the then Department of Forestry to adopt a policy of prescribed burning as the principal management tool on mountain lands (Le Roux 1966; Malherbe 1968; Wicht 1971a, 1971c; reviewed by Wicht and Kruger 1973) under its control (Garnett 1973). With the proclamation of the Mountain Catchment Areas Act (No. 63 of 1970) this policy was applied to private land, declared as Mountain Catchment Areas, for the primary aim of water conservation. Judicial application of this policy will augment domestic, industrial and agricultural water needs, but at the same time will be compatible with other catchment management objectives such as nature conservation and recreation.

Due to their peculiar combination of evolutionary, biogeographic and ecological features, fynbos ecosystems are of unique importance (Bands 1977; Kruger 1977d). Directly and indirectly mountain ecosystems are of economic value as they are the only presently available source of water for established and developing agriculture, industry, and the recreational potential of the Southern Cape region.

It is the Department of Environment Affairs' declared policy to manage catchment areas on State and other lands, entrusted to Departmental care for this purpose through the application of principles of multiple-use and the establishment and maintenance of management techniques on a permanent basis. Large scale afforestation with exotic timber species (predominantly *Pinus radiata*, *P. pinaster*, *P. elliotti* and *Eucalyptus diversicolor*) has been undertaken by the State on the southern slopes and foothills of the Outeniquie mountains, for the production of timber and poles (Van der Merwe *et al.* 1973).

The philosophy of multiple-use implies that forestry land be managed to produce timber, but at the same time conserve the fynbos ecosystem. Multiple-use implies that areas must be deliberately planned for such purposes. There must be carefully planned integration so that a minimum of clashes in use result.

On the basis that prescribed burning is now fully recognised as a management tool in pursuing management objectives, a mountain catchment planning section for the Tsitsikamma and Southern Cape Forest Regions was created in 1978. The first management plan was produced during

1980. The Policy Memorandum for the Outeniqua and Langkloof Mountains is part of the ongoing planning of the various catchment subsystems of the Southern Cape (Van der Zel 1981).

Fire management can be subdivided into two divisions: fire-control and fire-use. Fire-use entails the protection of State plantations by establishing fire-fighting organisations. On State Forests fire control implies the application of prescribed fires by management for beneficial purposes. Le Roux (1969) covered fire control on State Forests on the Outeniquas, and it is thus not discussed in this thesis. Our concern is the use of fire to achieve the aims of multi-purpose management of these mountain ranges.

Fynbos, also called Cape Macchia (Taylor 1978), is a sclerophyllous vegetation extending from approximately the Olifants River in the west to near Port Elizabeth in the east. Fynbos is a broad category of vegetations including mainly Acock's (1975) Veld Types 47 (Coastal Macchia), 69 (Macchia), and 70 (False Macchia). These comprise sclerophyllous shrublands of the mountains of the Cape Folded Belt, their foothills and the coastal forelands. When fynbos is mentioned in this thesis it implies Mountain Fynbos (Kruger 1979). A number of authors (e.g. Haughton 1969) state that the Langeberg Mountains extend to the Outeniqua Pass, and from there on eastwards are called the Outeniqua Mountains. The Langkloof Mountains occur east of the Keurbooms River. For the sake of convenience both of these mountains will be referred to as the Outeniqua mountains (or the Outeniquas). The term Outeniqua Catchment Area is used to include

both the State and private land on the Outeniqua mountains.

1.2 PLANNING PRINCIPLES

From the literature one finds little on practical management techniques for natural areas, such as the Outeniqua Catchment Area. A large volume of literature (e.g. Beale 1980; Selman 1981) describes various theoretical concepts, few of which have been tested in the practical management situation. In reality a particular area (ecosystem) is planned, with the planning based on a "feel" for the area by the planner. Seldom are actual criteria or methods stipulated, or systematic methods developed. Perhaps this will be the way planning of natural areas will always be, for as planning is being implemented natural ecosystems are changing.

Perhaps there is no set method: each area is unique and planning has to be adapted to each new area. However, it should be possible to formulate a number of basic management criteria to be applied in a variety of situations. In South Africa the science of management has received scant attention from terrestrial ecologists (Mentis 1980).

Foresters have for over a century been compiling and implementing management plans (Usher 1973). Descriptions of these plans and the methods employed in preparing them appear in a number of text books (e.g. Brasnett 1953; Knuchel 1953; Osmaton 1968). A more recent focus of conservation planning concerns nature reserves and wildlife

sanctuaries, and plans for their management have been compiled (Eggeling 1964; Usher 1967; Versey-FitzGerald 1975). There is a dearth of literature in this regard on South African conservation areas. Many of the principles used in this study have been gleaned from unpublished reports, personal communications, and my own experiences in the field of conservation management.

Environmental planning must ensure that society receives benefits but simultaneously has its environment preserved for future use. Thus ecological, economic, technical and social inputs should be considered in planning natural resources (Beale 1980). Once land has been allocated to a particular land-use it is difficult to restore it to its original state due to a lack of knowledge of means to reverse the process or the costs involved. *Gleichenia* infestations in the pine plantations in the Southern Cape is an example (Owen 1971). Wise initial allocation of land permits the best immediate and future use of particular areas of land. Planning of natural resources involves the management of the whole environment (Usher 1973), and therefore ecological principles should become a central theme in planning (Selman 1981). Planning essentially involves a long time-span (Eggeling 1964) due to the dynamic nature of ecosystems. Conservation management should be approached via applied ecology (Usher 1973), which involves the acquisition and application of knowledge based on past experience to achieve predetermined goals in managing ecosystems (Mentis 1980).

Strategies in applied ecology may be classified as either of the

deferred action type or of the adaptive type (Walters and Hilborn 1978):

- * a) deferred action implies that ecosystems cannot be managed until they are understood. Minimal disturbance may only be allowed until basic research elucidates key processes and relationships. Any attempts to rectify problems in an ecosystem are postponed until an improved understanding has been acquired.
- b) Adaptive action, in contrast, amounts to 'learning by doing'. Problems are tackled by a course of action which is believed will lead to the desired results. The inherent variability of ecosystems and errors in observing and interpreting them are taken into consideration. Mistakes are used as a test of the understanding of managerial ability (Mentis 1980).

The adaptive method will be followed in the management of the Outeniqua Catchment Area. Initial management decisions have been based on short term or on-the-spot studies of the area. Thus a first approximation of the ecological processes involved could be determined, whilst in years to come, as more accurate data becomes available, management prescriptions can be modified (deferred action). One obvious disadvantage is apparent. Initial management decisions may alter the course of development of the catchments in such a way that long-term studies will not represent entirely natural ecological processes. However, it was felt better to take a slight risk on

short-term studies rather than initiate no management practices until research yielded reliable data over the long term. It is important to remember that studies were carried out at a particular instant in time and the results of the survey can be seen as a hypothesis which can be tested by long-term studies. Progress in applied ecology is essentially adaptive; one learns to manage and manages to learn simultaneously (Mentis 1980).

Effective planning must proceed from an adequate understanding of the resources of an area, and all objective functions which bear upon them (Versey-FitzGerald 1975). The problem in planning and ecosystem studies involves a trade-off between obtaining an understanding of basic ecological processes and answering specific ecological questions pertinent to management problems. This involves finding a balance between detailed research on all aspects of the ecosystem's structure and dynamics, and empirical field experimentation based on intuition ("feel") and experience (Walker *et al.* 1978). A simple inventory of the natural features of the Outeniqua Catchment Area was accepted as the initial basis of understanding for planning.

Planning reflects the need to record, in detail, all that is known about a specific area (in this study the Outeniqua Catchment Area), what is proposed for it, the objectives of management, the methods by which they will be achieved, lessons learned, and a comprehensive set of instructions (policy) stating the work to be carried out within a specified period (Bigalke, pers. comm.).

1.3 OBJECTIVES

The purpose of this thesis is:

- a) To draw attention to the science of management, and the need to apply its important principles in manipulating a terrestrial ecosystem in the Southern Cape: the Outeniqua Catchment Area.
- b) To formulate management principles which will allow sound management of the fynbos catchment areas in the Outeniqua Catchment Area.
- c) To synthesize relevant published and unpublished information required to understand the structure and function of the ecosystem, under one cover and to deal with certain fields which have particular application to management, in greater depth.

1.4 METHODS

The adaptive strategy of applied ecology was used during this catchment planning exercise for the Outeniqua Catchment Area. Short-term studies were undertaken to obtain a basic understanding of the fynbos ecosystems, for planning purposes. An extensive literature survey was undertaken to ascertain what topics had been subject to detailed studies. Unfortunately the literature revealed that few such studies

had been undertaken within the Outeniqua Catchment Area. Many descriptions are therefore based on studies of relevant ecological parameters in similar mountain ecosystems.

As an adaptive method of planning was used, no specific survey method was implemented. A general impression of various ecological factors was obtained and reinforced with subsequent visits to the mountain. Personal observations and consultation of the literature were combined to give descriptions of various ecological parameters (e.g. climate and geology).

A vegetation survey of the mountain was conducted using Bond's (1981) structural/physiognomic method. Vegetation communities were mapped on 1:50 000 topocadastral sheets. Site factors (altitude, aspect, successional age of the veld, soil) of each community were noted. A light aircraft was used as a mobile observation platform, from moderate altitudes, to confirm community boundaries in inaccessible areas (Erikson 1980).

A land-use/water-use survey was undertaken on all private land within or adjacent to the Outeniqua Catchment Area. Private owners were visited and asked a series of questions (based on a questionnaire) concerning land and water use on their farms. They were asked how their activities fitted the regional pattern of water use.

An extensive literature survey on fire ecology was conducted as fire is an integral part of fynbos ecosystems and the management tool used

to achieve a variety of management objectives in the Outeniqua Catchment Area. Little information directly applicable to the mountains under study was found. The information, however, gave me a very thorough background of the role of fire in heathlands, and revealed that it still remains a controversial subject. Discussions with field and research personnel proved invaluable. Many suppositions were substantiated or refuted in the field.

All fire records from 1906 - 1982 were analysed to try and ascertain natural fire regimes in the area. This study proved very enlightening and gave one an indication of the important role fire plays in this ecosystem. Each fire record was studied and summaries of the relevant data were compiled. No statistical analysis on the data was possible due to the incompleteness of records. These data are summarized in Chapter 2.

CHAPTER 2

THE STUDY AREA

2.1 GENERAL BACKGROUND

2.1.1 Period of Planning

The Initial Management Plan for the Outeniqua Catchment Area is intended for the 15-year period 1983 to 1998, except where superseded by individual plans for smaller administrative units (e.g. individual State Forests). The policy contained in this memorandum is intended for the Initial Plan. A 15-year period has arbitrarily been chosen as burning ~~rotations~~ are in the vicinity of 15 years. Individual compartments will be burnt at different times so that after 15 years all compartments would have been burned once.

The necessity for revisions to the plan will be assessed after five years, based on current circumstances and improved knowledge. A full-scale assessment of monitoring results every five years will be undertaken before revising the plans.

2.1.2 Location and Access

Refer to Figures 2.1 and 2.2.

The Outeniqua mountains are a longitudinal range of folded mountains, which separates the coastal plain from the Little Karoo. The study area is located on these mountains between the Gouritz River in the west ($21^{\circ}20'E$) and the Keurbooms River and the Regional Boundary (between the Southern Cape and Tstisikamma Forest Regions) in the east ($23^{\circ}20'E$), slightly north of the 34th parallel.

State Forests stretch from Mossel Bay in the west to Plettenberg Bay in the east, on the southern slopes and foothills of the Outeniquas. Plantation areas on State land are often broken up by inaccessible valleys or patches of indigenous forests. Extensive areas of Outeniqua fynbos are located between the eucalyptus and pine plantations on the foothills, and the crest (watershed) of the mountains.

Private fynbos-covered catchment areas on the northern and southern slopes of the Outeniqua mountains and on the Langkloof mountains, and the portions of the Swartberg and Langkloof State Forests on the northern slopes are also considered in this report.

Access to all the points on the mountains is essential for management and fire protection. Four mountain passes (from west to east: Cloete'spas, Robinson's Pass, Outeniqua Pass and Prince Alfred's Pass) cross the mountains. Catchment areas on the northern slopes are

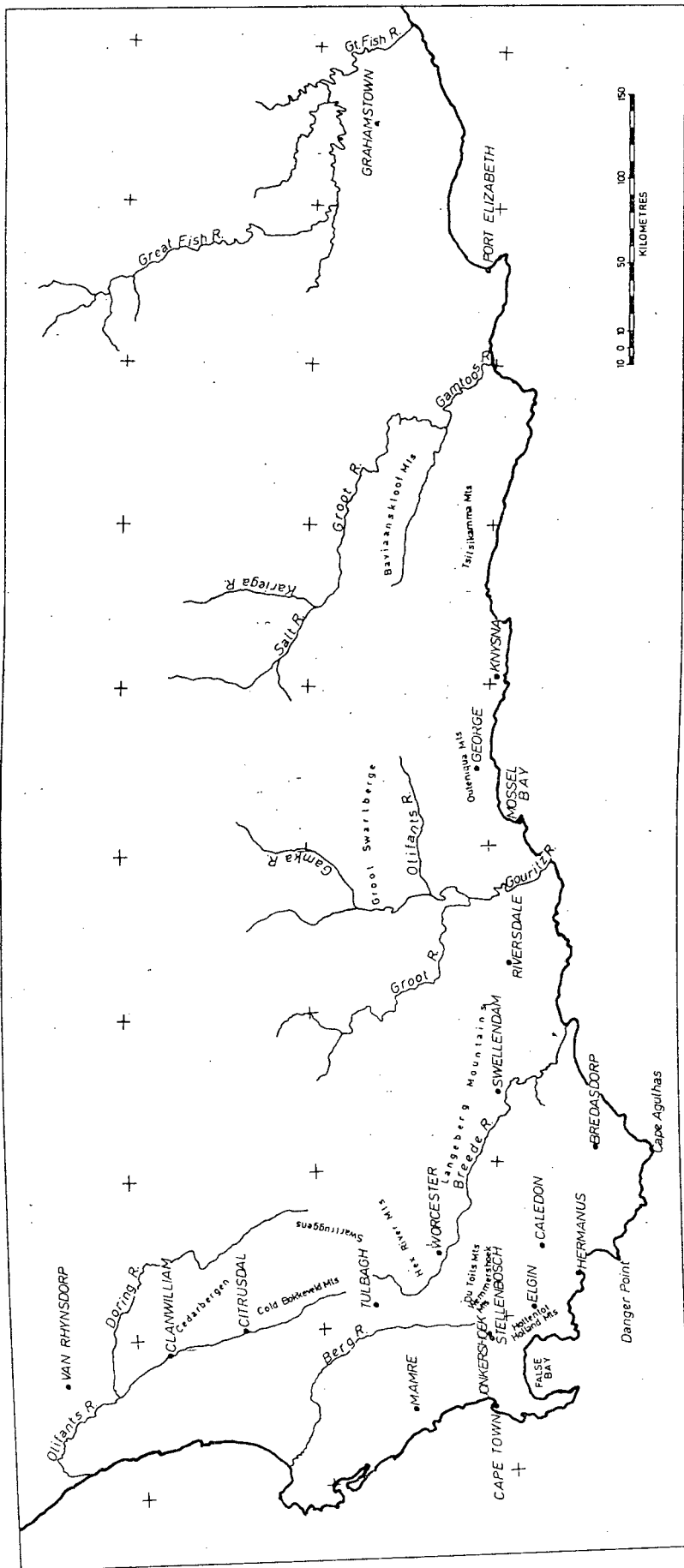


Figure 2.1 Location of the Outeniqua Catchment Area (Lambrechts 1979).

accessible by a number of well-maintained roads, which were constructed by the Department of Environment Affairs for fire protection purposes. Most catchment areas on the southern slopes are not served by roads or footpaths; access is only possible on foot.

2.1.3 Land Ownership and Legal Status

2.1.3.1 State land

State land on the Outeniqua Catchment Area is controlled by two State authorities, viz. the Department of Environment Affairs, and the Department of Agriculture (Table 2.1).

TABLE 2.1 Allocation of land: Outeniqua Catchment Area

Ownership	Area (ha)	% of total area
Department of Environment Affairs	69 425	49,2
Department of Agriculture	422	0,3
Private land (to be declared a mountain catchment area)	71 379	50,5
Total area of the Outeniqua Catchment Area	141 226	100,0

The Forest Act (No. 72 of 1968) provides the necessary statutory power for the management of catchment areas on State land. A large proportion of the State Forest land has been ensconced as demarcated forests in terms of Section 8 of the Forest Act.

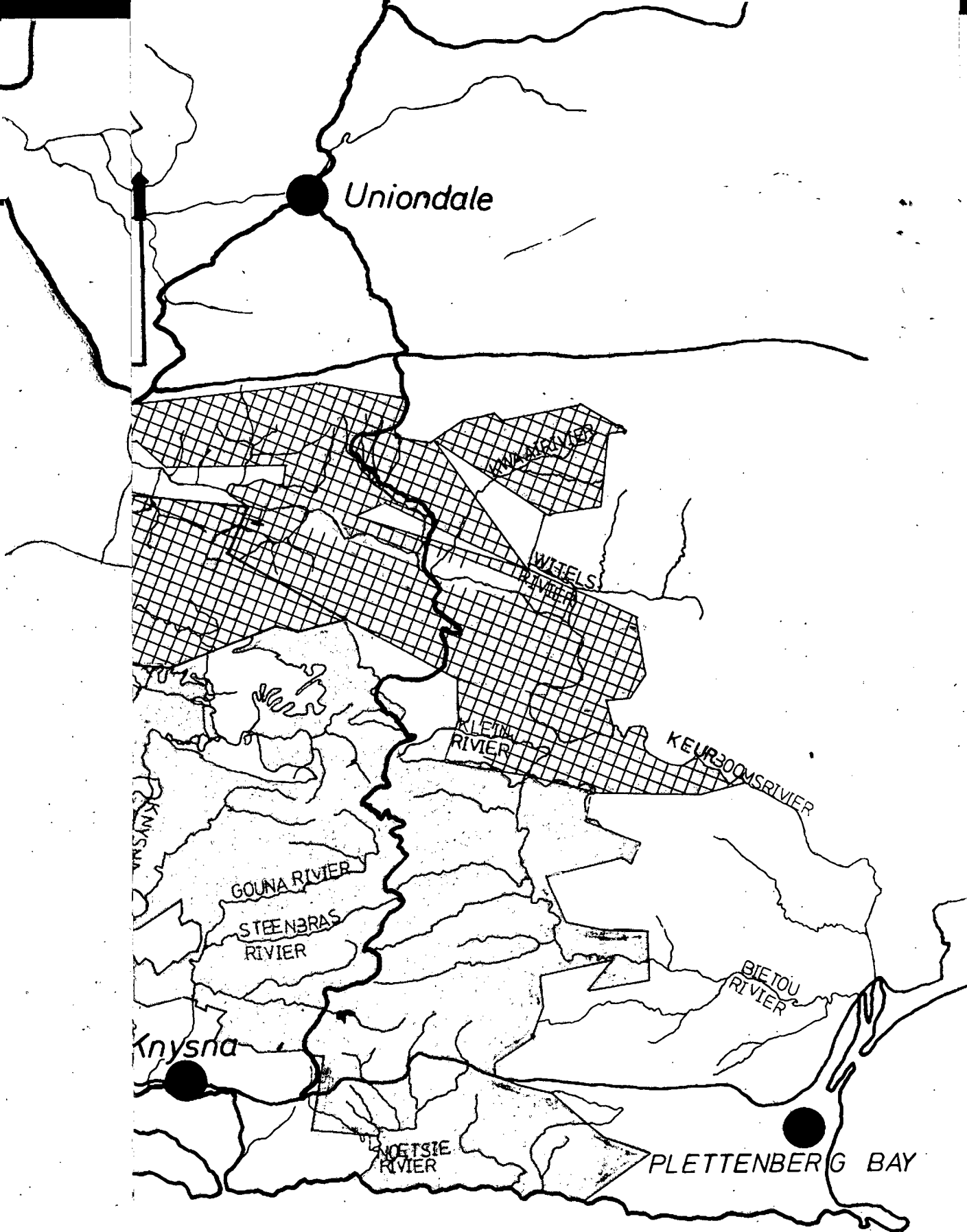
2.1.3.2 Private land

Appreciable areas of the Outeniqua Catchment Area are in private ownership. These properties should be declared a Mountain Catchment Area in terms of the Mountain ^{Catchment} Areas Act (No. 63 of 1970). For the purposes of this thesis it is not necessary to give individual details of each private property (viz. name of owner, address, area of land). This Act makes provision for the management of areas not under the direct control of the Department of Environment Affairs. The Minister may declare directions applicable to such land in regard to matters considered necessary for the achievement of the Act.




2.1.4 Boundaries

Refer to Figures 2.2 and 2.3.

The boundary of the Outeniqua Catchment Area includes the Outeniqua and Langkloof mountains. The southern boundary is formed by the fire belt (between the plantations and the fynbos catchments on State Forests) between the Keurbooms River and the Robinson's Pass, and from there westwards along the foot of the mountain to the Gouritz



*Location of private properties and State Forests,
and proposed Outeniqua Mountain Catchment Area.*

-  *Declared catchment area*
-  *Proposed catchment area*
-  *Indigenous Forest*

River. The northern boundary is formed by the foot of the Outeniqua and Langkloof mountains, which usually runs between fynbos and agricultural land. The Gouritz River forms the western and the Keurbooms River the eastern boundaries respectively. State and private land is therefore managed as a unit.

2.2 GEOLOGY, GEOMORPHOLOGY AND SOILS

2.2.1 Geology

Refer to Figure 2.4.

The catchment areas are underlain by sedimentary rocks of Ordovician and Silurian age, collectively referred to as the Table Mountain Group, which forms part of the Cape Super Group (Rust 1979). Table Mountain Group rocks are the main mountain builders of the Outeniqua mountains and therefore are of relevance to this study. This group is comprised of five formations (Toerien 1979) (Table 2.2). The Peninsula Formation forms the base of the Group. It is the thickest (± 1500 m) and most massive formation forming the highest peaks and the southern slopes of the Outeniquas. The formation is a white or pale grey, weathering, quartzitic sandstone with indistinct cross-bedding. A narrow, black shaleband 35 - 50 m thick, the Cedarberg Formation follows. A conspicuous shaleband outcrops in the Outeniqua and Montague Passes, passing just below the mapped contact between the Peninsula and Tchando Formations (Rust 1979). The Tchando (± 250 m)

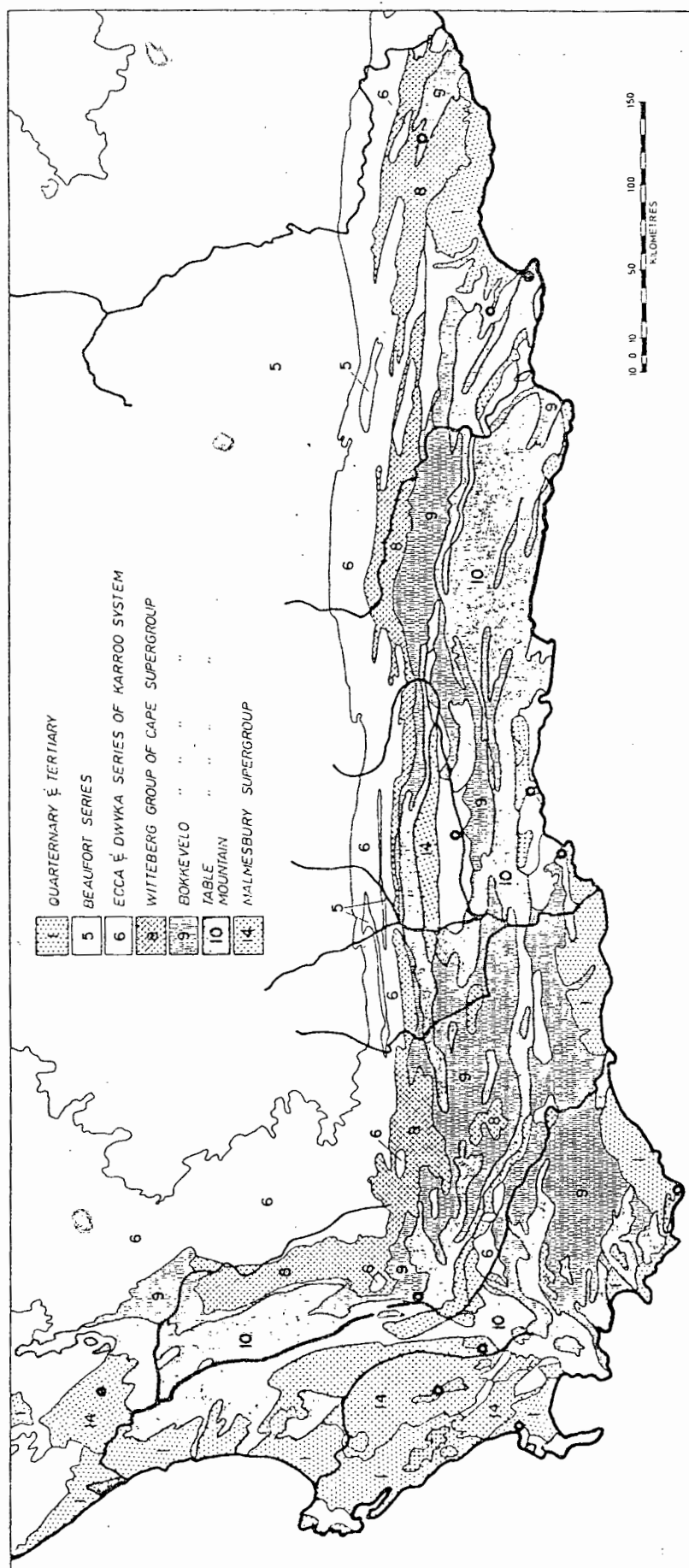


Figure 2,4 Geology of the Fynbos Biome (Lambrechts 1979).

overlies the Cedarberg Formation and is composed of reddish-brown or chocolate-coloured (iron and manganese oxides) sandstones containing frequent to subordinate shale bands. The Kouga Formation (300 - 400 m) follows: a prominently cross-bedded, quartzitic sandstone, distinguished from the Peninsula formation by a distinctive white colour. A 50 - 200 m thick formation, the Baviaanskloof, consisting of two dark-grey impure sandstones, separated by a felspathic zone, terminates the Group. The lowest and most northerly strata of the Table Mountain Group are formed by the Baviaanskloof (Truswell 1977; Van Daalen 1980; Bond 1981).

TABLE 2.2 Stratigraphy of the Table Mountain Group in the Southern Cape

Group	Formation	Type of rock (lithology)
Table Mountain	Baviaanskloof	sandstone with subordinate shale
	Kouga	white weathering sandstone
	Tchando	red-brown weathering sandstone
	Cedarberg	shale
	Peninsula	sandstone

2.2.2 Geomorphology

Two parallel mountain ranges, the Swartberg (inland) and the Outeniquas (coastal), striking in an east-west direction, and not far from

the coastline, dominate the landscape. The Little Karoo, a broad, lower-lying valley is located between the Outeniqua and Swartberg ranges. The coastal forelands, south of the Outeniquas, are formed by deeply incised remnants of a peneplain (or marine terrace) (Bond 1981).

The broad east-west trend of the mountain ranges and the steep southward dip of the formations is due to folding which occurred during the Cape orogeny (King 1963), and it imparted a strong structural control to the entire Southern Cape (Hughes and Görgens 1981). Isoclinal folding and over-folding are common in the area (Tait 1967). The southern slopes of the mountains resulted from over-folded anticlines. Faulting occurred during the Middle Cretaceous (King 1963) with a throw of approximately 3000 m at the southern foothills of the Outeniquas, near Robinson's Pass (Bond 1981). The Peninsula Formation is thus exposed from southern slope foothills to mountain crests. Due to the absence of faulting on the northern margins, the younger formations (Tchando, Kouga and Baviaanskloof) have been preserved (Bond 1981).

The relief of the area is dominated by the anti clinal, intensely folded, east-west trending Outeniqua mountains and foothills on highly weathered shales (Bokkeveld Group). In the west the Outeniquas reach a maximum height of some 1600 m, but become less distinct in the east where the Keurbooms River valley separates the Outeniqua from the Langkloof ranges. The study area consists of a succession of anticlines and synclines forming hills and valleys of decreasing

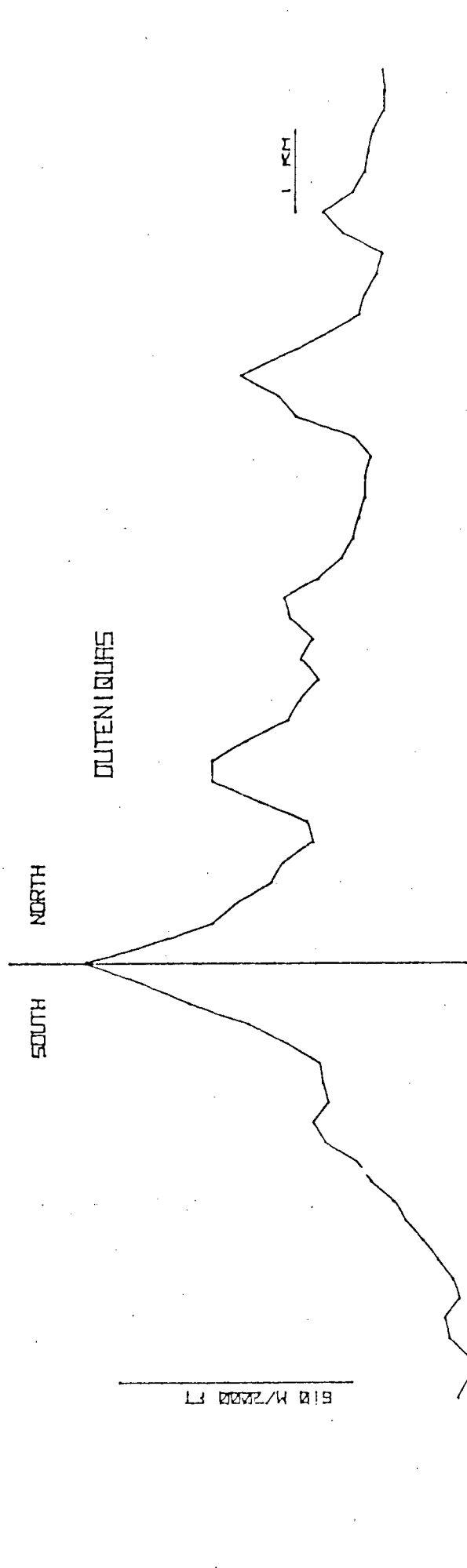


Figure 2.5 Transect across the Outeniqua mountains (Robinson's Pass) showing "southern" and "northern" slopes (Bond 1981).

elevation extending into the Little Karoo (Fig. 2.5) (Bond 1981).

2.2.3 Soils

Few studies of fynbos soils in the southern Cape have been published. Soils of the northern slopes were studied by Neethling (1970).

Bond's (1981) description of the soils in the Robinson's Pass area can at this stage be taken as being representative of soils on the Outeniquas. Northern slopes: These soils are mostly moderately deep, very rocky or stony, loamy sands and sandy loams overlaying hard rock or saprolite with abundant rock outcrops and boulders present. At higher elevations on steep slopes E horizons occur in Cartref soil forms. Mispah and Glenrosa soil forms occur on most mid and lower elevational slopes. Moderately deep and deep red, and dark brown soils (Hutton and Oakleaf forms) occur locally on talus slopes, pediments or remnants of Tertiary surfaces.

Southern slopes: More highly developed complex and more variable than soils of the northern slopes. They are mostly finer textured loams, fine sandy loams and clay loams, overlaying rock or ferrihumic subsoils, and are very acid (pH 3,3 to 5,1). Deep and moderately deep Hutton soils occur at lower elevations, apparently associated with relict erosion surfaces, often supporting *Protea aurea* communities. Moderately deep Oakleaf and Glenrosa forms (with dark brown subsoils) occur at mid and low elevations (usually on steep upper slopes). Cartref soils with elluviated, sandy, E horizons occur at higher

elevations (*Leucadendron uliginosum* often an indicator). High altitude slopes support deep peaty soils: A horizon high in organic material, overlaying rock.

Placaquods are associated with wet heaths, which occur on slopes directly exposed to rain-bearing winds and south-easterly, mist-bearing clouds. Peaty soils with a high water-table termed "hardpan" podsols: an organic rich A horizon overlaying a thin, brittle ironpan which impedes root and moisture penetration. These soils become infested with *Gleichenia polypodioides* if they are disturbed during the establishment of pine plantations (Owen 1970). This has important implications for management and extensive areas of plantations in the Southern Cape have been excised from active management due to infestation by *Gleichenia*. Bond (1981) confirmed the generalization (e.g. Neethling 1970; Kruger 1979; Van Daalen 1980) that fynbos soils are generally poor in bases, phosphorus and nitrogen, with considerable local variation, particularly in base status, depending on leaching regimes, from representative soil pits on the Swartberg and at Ruitersbos State Forst (Outeniquas). The concentration of bases is in the A horizon with S value and base saturation decreasing strongly in the B and E horizons. This implies nutrient concentration and retention in a closed nutrient cycle. Fire may play an important role in recycling these nutrients. Poor pine growth is experienced at Ruitersbos due to a manganese deficiency (Le Roux, pers. comm.). A wide range of fynbos communities cover manganese deficient areas with no obvious signs of change in composition or nutrient deficiencies in problem areas (Bond 1981; Directorate of Forestry 1982).

2.3 CLIMATE

Detailed descriptions of the climate are available in Tyson (1969), Jackson and Tyson (1971), Heydorn and Tinley (1980), Bond (1981) and Fuggle (1981) for the Southern and South Western Cape areas. Few weather stations are located in the Southern Cape mountains. This description is therefore biased to lowland stations adjacent to the Outeniquas, which fall under Schultze's (1965) region A.

2.3.1 Governing Parameters

The weather regime is controlled by an alternating succession of east moving cyclones originating from the circumpolar westerlies, centered over the south Atlantic. Anticyclones are subsiding dry air masses originating as perturbations in the circumpolar westerlies. They fluctuate in position, ridging south of the subcontinent, causing a predominance of easterly winds along the coasts particularly in summer (Jackson and Tyson 1971; Heydorn and Tinley 1980).

2.3.2 Precipitation

Virtually no rain gauges are located in the mountains. The Outeniquas receive rainfall throughout the year. Rainfall is usually of a low intensity and is orographic or cyclonic (Jackson 1947). A marked feature of the rainfall is the strong orographic control. Rainfall

may be in excess of 1100 mm on the high peaks, decreasing to 400 mm on the northern slopes. Table 2.3 gives mean annual and seasonal rainfall for selected stations in the Southern Cape in or near the study area (Bond 1981; Van Daalen 1982). Occasional snowfalls occur on the highest peaks (five to six times a year). No measures of mist precipitation are available for the mountains. Appreciable amounts of moisture could be precipitated as mist, especially from southeasterly winds during the summer months (Nagel 1962; Fuggle and Ashton 1979; Kruger 1979).

Thunder storms are rare and occur between 5 and 10 days per year (Schultze 1965). The lightning flash density (flashes/km²/year) for George and Mossel Bay respectively are 1,5 and 1,6 (NEERI 1982).

2.3.3 Temperature

No long-term temperature records are available for the Outeniquas. The climate is warm temperate with a distinct maritime influence (Philips 1931). Maximum temperatures range between 24,5°C in January and 19,4°C in June, while minimum temperatures range between 14,7°C in January and 8,2°C in June, for the coastal plain (Bond 1981). Warm temperatures in winter months, occasionally rising above 38°C, are due to hot, dry Berg winds (Tyson 1964). No quantitative information on temperature variation with altitude is available for the Outeniquas. Frost is reputed to seldom occur on the mountains. Table 2.4 gives temperature statistics for selected stations near the study area (Van Daalen 1980; Bond 1981).

TABLE 2.3 Mean annual and seasonal rainfall (mm) of the Outeniquas for selected stations in the Southern Cape (Bond 1981 and Van Daalen 1982)

Station	Co-ordinates		Height (m)	Period of measurement (years)	Mean Annual		Main Seasonal							
					Rainfall (mm)	Rainy days	Painfall (mm)			Rainy days				
	S	E					Dec.- Febr.	Mar.- May	June- Aug.	Sept- Nov.	Dec.- Febr.	Mar.- May	June- Aug.	Sept- Nov.
Southern Slopes														
Ruitersbos	33°54'	22°03'	229	20	780,4	83	192,5	214,5	130,7	233,7	30	22	17	24
Jonkersberg	33°55'	22°14'	457	56	1019,8	99	280,6	266,6	183,6	289,0	26	25	20	28
Geelhoutboomberg	33°55'	22°22'	460	43	815,5	98	219,2	205,9	158,0	232,4	26	25	18	29
Witfontein	33°55'	22°26'	610	21	932,9	91	259,8	264,9	167,4	240,8	25	24	18	24
George	33°58'	22°25'	229	98	868,8	122	236,0	225,0	163,4	244,4	32	31	25	34
Saasveld	33°58'	22°32'	223	43	850,7	91	220,8	220,4	169,8	239,7	23	23	19	26
Goudveld	33°55'	22°57'	216	88	815,9	106	214,4	205,3	163,2	233,0	27	27	21	31
Millwood	33°53'	22°59'	457	83	1058,0	122	286,3	263,3	197,6	310,8	33	30	23	36
Gouna	33°58'	23°03'	305	52	933,4	104	239,5	226,6	200,2	267,1	27	26	21	30
Diepwallie	33°57'	23°10'	519	36	1192,9	126	307,5	270,2	265,4	349,8	34	29	26	37
Kaffirkop	34°00'	23°13'	396	53	878,0	105	197,7	214,1	214,9	251,3	27	26	23	29
Northern Slopes														
Wagenboomskraal	33°53'	22°20'	579	26	823,7	64	194,9	190,8	175,2	262,8	14	15	15	20
Groot Doornrivier	33°53'	22°14'	533	35	238,9	30	41,2	167,2	64,5	66,0	4	8	9	9

TABLE 2.4 Mean monthly maximum and minimum temperatures (°C) for selected stations in the study area (Bond 1981)

Station:	Langkloof		Ruiterbos		George	
Period (years)	12		1		75	
Ht (m)	671		518		221	
Month	Max	Min	Max	Min	Max	Min
Jan	25,5	13,7	20,8	13,1	24,5	14,7
Feb	25,2	14,0	24,3	14,7	24,4	15,2
Mar	24,3	13,3	22,1	14,1	24,0	14,4
Apr	21,4	11,1	21,2	14,1	22,4	12,0
May	18,4	8,5	19,1	11,9	21,1	10,3
Jun	16,7	7,1	17,5	10,8	19,4	8,2
Jul	16,1	6,0	14,8	9,5	18,6	7,4
Aug	16,3	6,0	16,3	9,4	19,2	8,1
Sep	18,2	7,2	17,7	9,9	19,1	8,9
Oct	20,5	9,0	19,1	10,0	20,0	10,5
Nov	21,8	10,5	22,4	12,6	21,7	12,1
Dec	24,2	12,2	23,7	14,6	23,0	13,3
Year	20,7	9,9	19,8	12,1	21,5	11,3

2.3.4 Wind

Winds are controlled by the general circulation of South Africa (Jackson and Tyson 1971). Summer weather results from a displacement of the subtropical high pressure belt over the oceans. This belt appears as a dynamic system of anticyclones travelling eastward towards and along the coast, blocking the westerly cyclones (Kruger 1979). Strong south easterlies and warm weather result from this phenomenon. The Southern Cape receives rain throughout the year as mid-altitude depressions periodically penetrate inland bringing rain to the south coastal regions (Bond 1981).

Winter circulation of the South Western Cape is associated with perturbations in the circumpolar westerly winds, which move eastward as a succession of cyclones (depressions) and anticyclones, bringing rain to the south and east coasts. Fronts are associated with cyclones. Winds back from north west to west and south west, pressures rise, temperatures drop and instability storms and showers may occur (Jackson and Tyson 1971).

Berg winds often precede winter anticyclones. These hot, dry, gusty winds result from subsidence of air in the atmosphere in response to strong pressure gradients between an established anticyclone and an advancing depression. Maximum temperatures recorded in the mountains, and marked drops in temperature are associated with Berg winds (Tyson 1964; Fuggle 1981). They are of major ecological significance resulting in abnormal fire hazard conditions (Le Roux 1969).

The windrose for George (Fig. 2.6) indicates a strong south-easterly tendency in summer, a north westerly tendency in winter, but no major directional tendencies in spring and autumn.

2.3.5 Synthesis of Climate

The above survey only indicates broad trends apparent in the climatic mosaic of the Outeniquas. Reliable data are restricted to the coastal and Little Karoo recording stations in the interior, established to provide a generalized picture of climatic trends.

Climate plays an important role in determining fire danger and has a large influence on the intensity, velocity of distribution and eventual size that fires reach. Climatic factors related to fire-danger are wind, temperature, relative humidity and rainfall (Le Roux 1969). A critical combination of these factors results in a high fire-danger during the winter months when a Berg wind blows for extended periods. This is the reason why prescribed burning is not undertaken during the winter: the threat of fire-damage to the plantations on the southern slopes is too high.

Topography controls the strong precipitation gradients related to major differences in microclimate. Dominant aspects on these mountains are north and south. High relief results in steep slopes. The consequence of these factors for vegetation is considerable. Bond (1981) believes that available moisture is the most significant

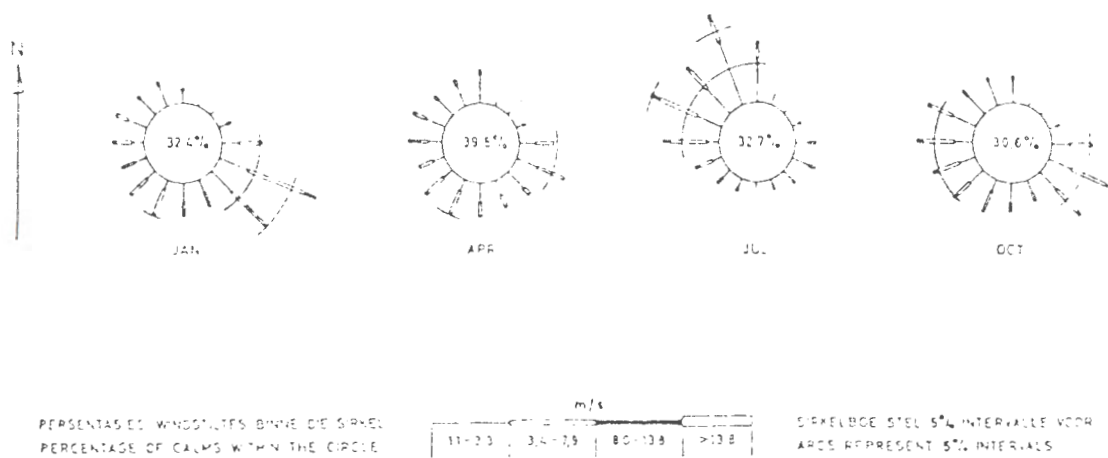


Figure 2.6 The windrose for Georæ (Bond 1981).

controlling factor on vegetation. These differences in the moisture regime are reflected in a complex pattern of vegetation communities on the mountain. Major differences are apparent on northern drier and southern moister aspects.

The vagaries of the weather, especially in winter, are one of the biggest dangers facing hikers on the Outeniqua Hiking Trail. Weather conditions can change dramatically within a few hours with an approaching cold front.

Climatic conditions are well-suited for afforestation, and extensive plantations of pines and eucalypts have been established.

2.4 WATER RESOURCES

Refer to Figure 2.3

2.4.1 General Regional Hydrology

The Outeniqua mountains are located in two drainage systems, namely, Gouritz and Southern Cape, their contribution to the total mean annual run-off both being 1,3% (Noble and Hemens 1978).

a) Gouritz Drainage System

The section of the Little Karoo east of the Gouritz River is drained by the Olifants and Kammanassie Rivers, which flow together south-east

of Oudtshoorn to form the Olifants River. The Olifants and Gamka Rivers converge south of Calitzdorp to form the Gouritz River, which enters the sea 30 km west of Mossel Bay. The tributaries of the Kammanassie River drain the northern slopes of the Outeniquas.

b) Southern Cape Coastal System

This system includes the Outeniqua and Tsitsikamma Mountains (Van der Zel 1980). The area, mean annual precipitation (MAP) and mean annual run-off (MAR) are as follows:

<u>Area (km²)</u>	<u>MAP (mm)</u>	<u>MAR</u>	
		mm	m ² x 10 ⁶
3146	911	174	547 048

Water input is principally by rainfall and occasional snowfalls. MAR on the mountains exceeds that of the area as a whole by 71% (574 mm as opposed to 335 mm). In terms of rainfall 26,8% of the Southern Cape's rain falls on the mountains. Due to the annual rainfall and evapotranspiration pattern in South Africa, run-off is concentrated from August to December, with low flows during January to February (Van der Zel 1981).

The tributaries of the Keurbooms River drain the eastern Outeniqua and the Langkloof Mountains. Southern slopes are drained by streams which discharge into the Indian Ocean or the Southern Cape Coastal Lakes Region (Hughes and Görgens 1981).

Mountain catchment streams are typically steep and fast-flowing with clear water, low in dissolved salts and nutrients (5 ug/l PO_4 ; Howard-Williams 1977). They are acid (ph 3,5 to 3,6) and on the southern slopes brown humic-stained water occurs in most of the streams (Du Toit 1966) (light transmission at 4 cm = 12%; Howard-Williams 1977).

Drainage follows fault lines and angular lines of weakness in sandstone beds resulting in a typical rectangular pattern (Joubert 1970; Hoekstra and Crabtree 1979), and many of the smaller tributaries are subsequent rivers. North flowing rivers are incised through the northern foothills which they cross without deviating from their path. Originating in the Outeniquas they flow through fairly open valleys, before leaving the mountain region through narrow valleys (Tait 1967).

2.4.2 Water-use Patterns

Water-use can be divided into two major categories: agriculture (irrigation and watering stock), and industrial/residential use.

a) Agriculture

Fairly large numbers of cattle and sheep are grazed on fallow lands and planted pastures (under irrigation) on the southern foothills of the Outeniquas and the coastal plain. Water from mountain streams is stored in small earth-dams and the water is then used to water

stock and irrigate lands. Fallow wheatlands and planted pastures (under irrigation) are grazed by sheep, cattle, goats and ostriches on the northern foothills. Drinking water is obtained from dams receiving water from the numerous mountain streams (Tait 1967).

Large-scale irrigation of orchards and vegetables takes place on the northern foothills and in the fairly open, east-west trending valleys on the northern slopes: irrigation water originating from the above-mentioned dams. Vegetables are cultivated on the coastal plain in the George area, and vegetables, orchards and vineyards on the foothills between the Gouritz River and the Robinson's Pass. The Kammanassie Dam receives water from northern slope tributaries and the water is used for large-scale irrigation along the Olifants River Valley.

b) Industrial and residential use

The towns of the coastal plain are dependent on the large-scale storage of water from the streams and rivers of the Outeniquas for industrial and domestic use. Table 2.5 indicates the dams which supply the various towns.

Ordinances of the Cape Provincial Administration and the Water Act (No. 54 of 1956) control the water quality of the streams.

TABLE 2.5 Sources of domestic and industrial water for towns in the Southern Cape coastal region.

Town	Population (3)	Dam(s)	Dam capacity (kilolitres)
Plettenberg Bay	5 346	Weir on Keurbooms River: water diverted into a reservoir	(1)
Knysna	32 000	Glebe Akkerkloof Cowlie Weir; Gouna State Forest	(1) 134 000 (2)
George	56 645	Swart river dam	217 000 (2)
Groot Brak	2 100	Kenhart, Osdam, Klipdam, Power dam	264 978 (4)
Mossel Bay	33 642	Klein dam Sandhoogte Hartbeeskuildam Hartenbos River pump	(1)
Herbertsdale		Pump; Langtou River	(1)

Notes (1) No data available

(2) Information on dams obtained from various Town Engineers

(3) Population figures from 1980 census

(4) Stauth, pers. comm.

2.4.3 Geohydrology

The Outeniqua mountains are predominantly composed of quartzitic sandstones. Table Mountain Sandstone is an important aquifer (Enslin 1964), due to its secondary fracture porosity, which varies

between 1 and 14%, and its large volume (Joubert 1970). Fault structures are favourable permeable zones (Rossouw *et al.* 1964). Primary intergranular porosity is low due to cementation of grains and probably does not exceed a fraction of a percent. Porosity is increased near the surface due to weathering and leaching. Joints, faults, bedding planes and contact planes are jointly responsible for the bulk regional porosity of Table Mountain Sandstone (Joubert 1970).

As the ranges are built up of Table Mountain Sandstone and they are zones of high precipitation, regular recharge of the aquifer is ensured. An estimated 60% of precipitation on sandstone outcrops contributes to recharge. Recharge of Table Mountain Sandstone occurs by infiltration of rainwater and snowmelt water. The high porosity mantle soaks up most of the immediate precipitation thus minimizing run-off. The mantle slowly releases water into the fracture system, which serve as regional aquifers (Joubert 1970). Base flow depends on retarded flow through the soil/rock mantle and fractured bed-rocks, evidenced by the presence of seepage zones (Bosch 1979) and a year-round flow even in small streams.

Soils are resistant to erosion (Kruger 1977b) and therefore the water quality from undisturbed catchments is high (Van Wyk 1981). Little surface run-off occurs, even in intense rain.

2.4.4 Synthesis of Hydrology

The hydrological importance of the Outeniqua mountains can be summarized as follows:

- a) The mountains form high obstructions resulting in orographic rains. Mist formations during south-easterly wind conditions (which prevail in summer) may augment streamflow (maximum water availability).
- b) Depending on geology and vegetation characteristics, the mountains can be seen as water reservoirs. Water is available over long periods by perennial or seasonal run-off, springs or boreholes (perennial water availability).
- c) Table Mountain Sandstone (the material which forms the mountains) is very resistant to erosion and therefore ensures high water quality. Farmers on the Bokkeveld shales in the Little Karoo, adjacent to the Outeniquas, are dependent on the non-saline water in the mountain streams. Due to the high sediment load in the Karoo streams siltation is a problem. Silt loads vary, depending on the intensity of the rainfall and the area in which it rains, and the time of the year. Silt loads are the highest during storms, which fill the Karoo dams but also cause siltation. In contrast, mountain streams have a very low silt load (Claasen 1978).

Intermittent spates are received by the Gouritz drainage system due to

summer rains in the dry interior. Perennial flow is derived from tributaries in the mountain catchments, which receive a more constant reliable precipitation.

2.5 VEGETATION

2.5.1 Classification of Vegetation

Recently several reviews on the woody vegetation of the South-western and Southern Cape have appeared in the literature (Taylor 1978; Goldblatt 1978; Kruger 1979; Bond 1981). However, with the exception of the Knysna forests, few detailed vegetation studies have been undertaken on the Southern Cape coastal mountains. The only detailed, published accounts of the vegetation are Muir's (1929) work in the Riversdale district and Phillip's (1931) account of successional patterns in the Knysna Forests. Seydack and Horne (1980) recently compiled a vegetation map of the Moordkuils-rivier catchment, which served as a basis for catchment planning in the area.

Table 2.6 gives broad categories of vegetation which can be identified on the Outeniqua Catchment Area.

TABLE 2.6 Acock's (1975) Veld Types in the Outeniqua Catchment Area in relation to substrate and moisture regime (Bond 1981). (The numbers in parentheses following the names of the vegetation are Acock's veld type numbers.)

Moisture Regime (1)	Base Rich	Base Poor
Mesic		False Macchia (70) Knysna Forest (4)
Intermediate	Mountain Renosterveld (43) Coastal Renosterveld (46)	False Macchia (70)
Xeric	Gouritz River Shrub (23)	False Macchia (70)

(1) Acocks (1975) refers to all Macchia or Fynbos east of Montague as False Macchia but Taylor (1978) and Kruger (1979) have included both Macchia and False Macchia in Mountain Fynbos. Later writers have distinguished between various Fynbos communities in these areas.

2.5.2 Community Descriptions

a) Renosterveld

i) Mountain renosterveld (43)

This community occurs on the northern foothills and lower-lying valleys of the northern slopes of the mountains, mostly on shale substrata. It is bounded by succulent Karoo to the north (31) (Tainton 1981). Mean height of the shrubs is approximately 1 m and the crown cover is moderately high. The upper shrub layer is mostly composed of *Elytropappus rhinocerotis* (Muir 1929). Ground cover is

often low and sometimes contains a fairly high grass component.

Species diversity in this veldtype is low.

ii) Coastal renosterveld (46)

Occurs at an altitude of 0 - 300 m and is present on the lower southern foothills on clayey soils (Cretaceous and Recent sediments). It has been almost completely ploughed up for growing wheat so that relics of natural vegetation are scarce and in poor condition. Natural vegetation appears to have been scrub: perhaps, judging by relics in certain river valleys (pers. obs.), very dense and thorny, with *Olea africana* and *Sideroxylon inerme* the dominants. Lower areas of valleys may have been drier, a semi-succulent scrub, in which *Acacia karroo*, *Aloe arborescens* and *A. ferox* are conspicuous, while the upper part of the valleys appear to have forest transitional to the forest of the Langeberg. Renosterveld has replaced the scrub where the soil is predominantly shale. Grass often predominates in protected places which have never been ploughed, the predominant species being *Themeda triandra*. At the upper margin of this veld, where it becomes transitional to Mountain and Coastal Fynbos, sour grasses come in, e.g. *Aristida junciformis*.

b) Gouritz River scrub

Gouritz River scrub (a variation of Valley Bushveld) occurs in the valley of the Gouritz River. In its undamaged state it is an extremely dense, semi-succulent, thorny, scrub, about 2 m high. A prominent feature are the the tall *Aloe* spp. (*A. ferox*, *A. speciosa*, *A. arborescens*).

It merges upwards into Fynbos and Renosterveld.

c) Mountain fynbos

Most of the Outeniqua Catchment Area is covered by fynbos (Veld Type No. 70; False Macchia). Bond (1981) developed a physiognomic classification for fynbos in the Ruitersbos area, and gives the major structural groups as follows:

i) Heathlands (symbol H):

Typical of high elevations (1000 m +) but may extend to lower elevations, especially on soils with seasonally or perennially high water tables. They are low (0,5 - 1,5 m) shrublands with a high vegetative cover dominated by Ericaceae (not less than 50% of non-proteoid shrub cover). Penaeaceae, Grubbiaceae and Bruniaceae are typical heath associates. Proteoid shrubs are poor in species and do not exceed 10% cover. Graminoids are important components and usually exceed, or equal, total small-leaved shrub cover. The relative cover of grasses, restios and sedges is of diagnostic significance in distinguishing heathland types. Rosette or prostrate soft-leaved forbs and evergreen geophytes are characteristic of the ground layer.

ii) Proteoid Shrublands (Proteaveld) (P):

Occur over a wide range of elevations (450 - 1000 m) in areas of rainfall of 600 - 1000 mm. Proteoid shrublands are medium (1 - 2 m) tall or tall (2 m +) communities. They are layered communities with two or three layers dominated by shrubs and graminoids. Proteaceae are visually prominent members of the community. Unfortunately

their diagnostic value is limited by major fluctuations in plant density in relation to fire history.

iii) Restioid Shrublands (Restioveld) (R):

Characteristic of northern aspects, or shallow, rocky soils (Mispah, Glenrosa) over a wide altitudinal range. Low to mid-height graminoid shrublands dominated by Restionaceae. Tall (1 m +) coarse-stemmed restios with broad tussocks (e.g. *Cannamois dregei*) are characteristic growth forms. Proteaceae are generally present but proteoid density in successive generations may fluctuate widely in this veldtype. Small-leaved shrubs have a lower total cover than graminoids. Low shrubs (less than 50 cm) are common but usually subordinate to restios.

iv) Dry Shrublands (W-Waboomveld, A-Arid Fynbos)

They include Waboomveld and Arid fynbos (Taylor 1978). Occur at mid to low elevations with a mean annual rainfall of 250-750 mm. Dry shrublands integrate with proteoid veld with a non-ericaceous understorey, or restioveld. A number of characteristics distinguish it from these types. Tall serotinous Proteaceae are usually absent but are replaced by an open or sparse cover of species surviving fire by root sprouts, epicormic shoots or soil-stored seeds. Non-ericaceous shrubs dominate the small-leaved shrub strata. Inrolled, non-ericaceous leaves, and elyotropappoid or semi-succulent ("fleshy") growth forms are well represented. Stem spinescence and stem and leaf succulence characterises the more xeric phases. The graminoid layer is usually low with soft, broad-leaved C4 grasses present.

Restios are always present, but the cover is typically low and the distribution is patchy with discrete tussocks separated by several metres.

d) Knysna Forest (4)

As part of the Afrotemperate forest biome, the midlands forest is considered to be temperate, but has subtropical associations. Most of the flora is derived from tropical or subtropical species, but the type of forest, with its relatively few species of lianas and epiphytes, is clearly temperate (Geldenhuis 1980). Indigenous forest (sclerophyllous *Podocarpus*, *Ocotea* and *Cunonia* forests) occur in moist protected valleys in the mountains (Bond 1981). Dry forest in steep kloofs may only reach 12 - 15 m.

A detailed vegetation map was compiled as part of the catchment management exercise. In Chapter 1 I discussed the methodology of the mapping technique. Table 2.7 gives a summary of the major structural groups on the Outeniqua Catchment Area. Ten structural groups have been identified on the Outeniqua mountains.

2.5.3 Characteristics of the Flora

Due to the richness and degree of endemism of the Cape Flora it has been placed in a separate floristic kingdom (Good 1964; Takhtajan 1969). When compared with other areas with a Mediterranean climate the Cape Region is very rich in species and has a large degree of endemism at genus and species level (Goldblatt 1978).

TABLE 2.7 Summary of major structural groups on the Outeniqua Mountains. Units were defined informally by mixed floristic/structural physiognomic criteria

Name of structural group	Communities	Symbol	Habitat	Diagnostic features
<u>Fynbos</u>				
Heathlands				
		H		
	Wet heathlands; southern slopes	H1S	Wet south slopes. 600 m to mountain crests	Dense, small-leaved shrubland; 0.5-1.0 m high. Restioid cover more than 50%. Mid-dense, small-leaved ericoid/restioid shrubland. Scattered broad-leaved shrubs. Height 0.5 to 1.0 m
	northern slopes	H1N	Wet north slopes. 700 m to mountain crests	
	Graminoid heathlands	H2	Steep rocky north aspects 380-1060 m	Tall open canopy of <i>Seimochellus multiflorus</i> / <i>Erica viridescens</i>
Proteoid shrublands				
	Proteoid shrublands with a heath under-storey. Medium-tall mid-dense <i>Leucadendron eucalyptifolium</i> / <i>Protea mundii</i> / <i>P. neriifolia</i> shrubland	P1	Mesic south aspects: 400-1160 m	Closed canopy formed by these species. Dense under-storey of restioids, graminoids and small-leaved shrubs
	Tall sparse to mid-dense <i>Leucadendron uliginosum</i> shrubland with a closed to open heath under-storey	P1b	Gravelly soils on N and NE aspects at higher elevations; 370-1240 m	<i>L. uliginosum</i> visual dominant in the canopy. Under-storey varies from a closed to an open heath
	Tall mid-dense <i>L. eucalyptifolium</i> / <i>Betzelia</i> intermediata shrubland	P1c	Steep mesic south aspects: 300-1230 m	Dense canopy of broad sclerophyll proteoid leaves: 1.5-2.0 m overlies a small-leaved ericoid understorey
	Medium tall mid-dense <i>P. neriifolia</i> / <i>P. coronata</i> shrubland	P1d	Low to mid-altitude southern slopes; 350-880 m	Fairly open canopy of proteoid leaves. Ericoid understorey
	Tall dense <i>P. aurea</i> shrubland	P2	Lower elevations, south and north aspects; 420-1000 m	May form woodlands with a dense canopy; sparse cyperoid understorey
	Proteoid shrublands with a mixed ericaceous/graminoid under-storey	P3		
	Medium-tall dense, <i>P. neriifolia</i> / <i>P. mundii</i> shrubland	P3a	Moderately steep, mesic northerly aspects	Canopy a proteoid layer 1-2 m tall. Understorey dominated by shrubs and graminoids
	Medium-tall, dense <i>P. neponis</i> shrubland	P3b	Valley bottoms, northern slopes; 550-625 m	Proteoid canopy 1-2 m dominated by <i>P. neponis</i>

Table 2.7 (continued)

Name of structural group	Communities	Symbol	Habitat	Diagnostic features
Restioid Shrublands	Medium-tall, mid-dense <i>Elegia galpinii</i> shrubland with emergent proteoids	R1	North aspects, shallow rocky soils: 610-1210 m	Tall coarse-stemmed restios with broad tussocks. Proteoids are generally present.
	Medium-tall mid-dense restioid shrublands	R2	Mesic colluvial soils; north slope valley bottoms 640-890 m	Restio tussocks 1-2 m tall emergent proteoids
Dry Shrublands	Waboomveld (medium-tall to low mid-dense to open <i>P. nitida</i> shrubland)	W1	Mid and lower elevations 600-900 m on northern talus slopes	Very variable. <i>P. nitida</i> always present. Rich in C4 grasses
	Arid Fynbos	A	Lower northern foothills 300-600 m. Shallow stony soils	Low, open or sparse shrublands dominated by shrubs. Restios seldom important
Riverine Fringe Community		RF	Along water courses of various lateral extension	Variable and depends whether <i>Virgilia</i> <i>onoboides</i> , <i>Brachyleana neriifolia</i> or forest elements form the dominant component
<u>Forest</u>				
Montane forest		F	Kloofs and deep depressions on south and north slopes	Closed canopy of tall forest tree species: 6-15 m tall
<u>Karoo Types</u>				
Renosterveld		K	Foot of the northern slopes: 300-600 m	Short shrubland (0,5-1,5 m). Canopy dominated by ericoid-leaved shrubs
Valley bushveld	Gouritz River Scrub	V1	Valleys of these two rivers	Extremely dense, semi-succulent, thorny scrub 1 - 2 m tall
	Keurbooms River Scrub	V2		

The rugged and variable topography of the Outeniquas provides a variety of habitats for a wide range of plant species. The range rises from the coastal plain and Little Karoo to tall peaks resulting in a sharp altitudinal gradient, which has a marked influence on the moisture regimes and thus community structure and composition (Bond 1981; Seydack *et al.* 1981). Botanically, the area is relatively unexplored and could possibly yield a number of new species (Seydack and Horne 1980). A distinct Western Cape ecological and plant geographical influence is present in the area between the Gouritz River and the Robinson's Pass (Bond, pers. comm.), but as yet has not been adequately described. In conclusion, it can be said that the Outeniquas supports a rich flora which is of great scientific importance, especially with reference to species richness, migration routes (Seydack *et al.* 1981) and distribution patterns.

Known endangered and rare species, and conspicuous species of the Outeniquas appear in Tables 2.8 and 2.9.

2.5.4 Problem Plants

Few areas of the Outeniquas are free of exotic vegetation, and certain areas have been so overrun that little indigenous vegetation remains. A provisional list of problem plants is given in Table 2.10. Invasion of fynbos by woody vegetation has long been recognized as a severe threat to the vegetation (Boucher and Boucher 1978). The exotic species on the Outeniquas originate from ~~regions~~ with similar

TABLE 2.8 List of rare and endangered plant species in the Outeniqua Catchment Area (Hall *et al.* 1980; Seydack and Horne 1980; Bond, pers. comm.; Le Roux, pers. comm.)

Species	Locality	Status
<i>Leucospermum formosum</i>	1. Karatara State Forest (Klein-plaat, Duiwelsberg)	R
	2. West of Robinson's Pass (Kouma River valley)	R
<i>L. secundifolium</i>	Moordkuilsrivier catchment	R
<i>L. glabrum</i>	1. Near George eastwards sporadically to the Prince Alfred's Pass	
	2. May occur in Moordkuilsrivier catchment	R
<i>Mimetes pauciflorus</i>	1. Scattered populations on the southern slopes	
	2. Moordkuilsrivier catchment	R
<i>Leucadendron ericifolium</i>	1. Moordkuilsrivier catchment	
	2. Grootdoringrivier catchment	R
<i>Acrolaphia undulata</i>	Possibly Moordkuilsrivier catchment	E
<i>Eulophia tabularis</i>	Possibly Moordkuilsrivier catchment	R
<i>Acmadenia rupicola</i>	Near Robinson's Pass	R
<i>Mimetes splendida</i>	1. Ysternek Nature Reserve	
	2. Karatara State Forest	R
<i>Leucospermum pluridens</i>	Between Safraanrivier and Moerasrivier; northern foothills	R
<i>Paranomous longicaulis</i>	Attakwasberg/Ruitersbos area	R
<i>Protea lanceolata</i>	Attakwasberg/Ruitersbos area	R
<i>Anisodonteia alexandri</i>	George area	Believed extinct

- continued

Table 2.8 (continued)

Species	Locality	Status
<i>Thamnochortus muirii</i>	George area	V
<i>Penaea cneorum</i> spp. <i>cneorum</i>	George to Prince Alfred's Pass	R
<i>Leucadendron oleos</i>	Groot Doringrivier valley	X

KEY

R = rare

E = extinct

V = vulnerable

X = A new species not listed in Hall *et al.* 1980, but deserving the status of rare due to its very local distribution

TABLE 2.9 List of species of particular interest in the Outeniqua Catchment Area (after Seydack and Horne 1980; Bond, pers. comm.).

SPECIES	LOCALITY	REMARKS
<i>Protea aurea</i>	1. Moordkuilsrivier catchment Koumarivier valley, Waboonskraal 2. Cloetespas	Scattered populations. Much of habitat cultivated or afforested. Short rotation burning for grazing
<i>Protea macrocephala</i>	Moordkuilsrivier catchment	Widespread but nowhere common
<i>Serruria burmanni</i>	Moordkuilsrivier catchment	Most easterly distribution
<i>Penaea mucronata</i>	Moordkuilsrivier catchment	Most easterly distribution
<i>Vallota speciosa</i> (George lily) Orchidaceae	Moordkuilsrivier catchment Many attractive orchids occur throughout this area	Attractive geophyte
<i>Protea grandiceps</i>	Koumarivier valley, Molenrivier	Small isolated populations
<i>Leucodendron comosum</i>	Northern slopes Attakwasberg	Single small population
<i>L. rubrum</i>	Northern slopes Attakwasberg	Large attractive cones
<i>Mimetes cucullata</i>	Attakwasberg	Localized populations
<i>Protea?aulax</i>	Koumarivier valley	Locally scarce
<i>Leucodendron teritifolium</i>	Northern slopes Attakwasberg	Locally scarce

TABLE 2.10 Principal problem plants in the Outeniqua Catchment Area

WEED SPECIES	METHOD OF SPREAD	NOTES
<u>Exotic species</u>		
i) Pines		
<i>Pinus pinaster</i>	1. Seed (wind dispersed) 2. Baboons (Van der Merwe, pers. comm.)	Wind dispersal is highly effective in spreading seeds: seedlings are regularly found 1000 m from nearest adult trees. Seedlings can become established in 12-18 year old fynbos (Kruger 1977a)
ii) Wattles		
<i>Acacia mearnsii</i> <i>A. cyclops</i> <i>A. saligna</i>	1. Seed (birds: Glyphis et al. 1981; Milton 1980b) 2. Construction of road and railway embankments	Seed remains viable for over 50 years (Directorate of Forestry and Environmental Conservation 1981). Fire stimulates germination. Stream beds are easily infested with black wattle
iii) <i>Hakea sericea</i>	Seed (wind: Fugler 1979, 1982)	<i>Hakea</i> cannot establish itself in mature fynbos; infestation only occurs after fires. Winged seed can be blown several kilometres.
<u>Indigenous species</u>		
iv) Renosterbos		
<i>Elytropis</i> <i>rhinocerotus</i>	Seed (Levyns 1929)	Almost pure stands result from incorrect season of burn in the Keurbooms River valley (Meyer, pers. comm.). Regenerates with difficulty in dense grassveld.

- continued

Table 2.10 (continued)

WEED SPECIES	METHOD OF SPREAD	NOTES
v) Keistervaring		
<i>Gleichenia poly-</i> <i>podoides</i>	1. Vegetatively 2. Seeds (gravity) (Owen 1971)	Colonizes soils derived from sandstone and quartz low in phosphorus after soil disturbance, e.g. afforestation

climates and also with infertile soils like those of the Southern and South-western Cape Fugler 1982). They are therefore able to readily immigrate into undisturbed fynbos communities (Kruger 1979). All are adapted to survive typical fire regimes in fynbos, reproduce profusely after fires establishing dense populations which (as is the case with *Hakea sericea* in the Outeniqua Catchment Area) may suppress the natural communities almost to the point of extinction (Kruger 1977a; Fugler 1979; Kruger 1979; Milton 1980a).

Disadvantages of the presence of woody invasive species are changes in community structure and reduction in species diversity (Cowling *et al.* 1976), an increased fire hazard due to increased fuel load and reduced accessibility (Kruger 1977c), decrease of surface water resources (Jordaan and Van Zyl 1976; Kruger 1977a) and the reduction of the aesthetic, recreational and scientific values of the fynbos communities.

2.6 FAUNA

2.6.1 Species Present

The Southern Cape is a distinct biotic subregion of the Aethiopian Region (Davis 1962), but is not one of major importance. It is by no means as distinct faunistically as floristically (Bigalke 1980). Typical fynbos species occur in the Outeniquas (Breytenback, pers.

comm.). Very little literature is available on the ecology of the depauperate small and large mammalian fauna of the mountains in the Southern Cape (Meester 1965; Rautenbach 1978). Mammalian fauna is composed of some archaic elements and some derivatives of southern savannah and grassland fauna (Rautenbach and Nel 1980). At this stage knowledge of the fauna is almost restricted to a checklist of amphibians, reptiles, birds and mammals (Breytenbach *pers. comm.*).

The Outeniquas provide habitat for a comparatively long list of faunal species and provides a wildlife sanctuary in the Southern Cape.

The provisional checklist contains six species of fishes, 15 species of amphibia, 42 species of mammals, 28 species of reptiles (Breytenbach *loc. cit.*) and 64 species of birds (Seydack and Horne 1980).

An understanding of small mammal distribution and dynamics will be of great value in conservation management of the mountains. Present evidence that rodents regularly pollinate two *Protea* spp. (Wiens and Rourke 1978; Rourke 1980) and the role of indigenous ants in the dispersal of the proteaceous genera (Slingsby and Bond 1981; Bond and Slingsby 1982) emphasize the urgent need to ascertain the role of the fauna in the ecology of the Outeniquas.

Unfortunately management proposals will be prescribed without an adequate understanding of the fauna.

Table 2.11 lists rare or endangered fauna of the South African Red Data Book which have been recorded in the area.

TABLE 2.11 Wildlife species of the Outeniqua Catchment Area listed in the South African Red Data Book

a) Class: Aves (Birds) (After Siegfried *et al.* 1976)

<u>Species</u>	<u>Status</u>	<u>Notes</u>
<i>Bradypterus victorini</i> (Victorin's scrub warbler)	R	
<i>Poliospiza leucoptera</i> (Protea seed-eater)	R	

b) Class: Mammalia (Mammals)

b1) Small mammals (Meester 1976)

<i>Praomys verreauxi</i> (Verreaux's rat)	R	
<i>Acomys subspinosus</i> (Spiny mouse)	R	
<i>Mellivora capensis</i> (Honey Badger)	R	

b2) Large mammals (Skinner *et al.* 1977)

<i>Panthera pardus</i> (Leopard)	R	
----------------------------------	---	--

c) Class: Pisces (Fishes) (Skelton 1977)

<i>Barbus afer</i> (Eastern Cape redfin)	R	Endemic
<i>B. asper</i> (Small Redfin)	R	Endemic
<i>B. burchelli</i> (Burchell's Redfin)	R	Endemic

d) Class: Reptilia (Reptiles) and Class: *Amphibia* : none listed (McLachlan 1978)

KEY: R = Rare

2.6.2 Exotic Species

Trout (*Salmo trutta*) have been introduced into the Keurbooms River (Reid pers. comm.). The impact of this exotic species is unknown. As the trout does not breed in the brown, acid water the rivers have to be periodically restocked.

2.6.3 Problem Animals

Predatory animals regarded as problem animals in areas where small stock graze are present in the area. These include caracal (*Felis caracal*), black-backed jackal (*Canis mesomelas*), leopard (*Panthera pardus*), baboon (*Papio ursinus*) and black eagle (*Aquila verreauxi*). Baboons damage agricultural crops and aid the distribution of *P. pinaster* in the mountains. The other problem animals occasionally kill small stock. Black eagle are often blamed for damage caused by the pied crow (*Corvus albus*) (Department of Nature and Environmental Conservation, undated).

2.7 FIRE ECOLOGY

2.7.1 Introduction

Fires play a major role in the maintenance of the heathlands of the world and are of importance due to their effect on plant and animal

productivity (Gill and Groves 1980). Periodic fires have occurred in fynbos vegetation for probably 100 000 years and possibly since the early Pleistocene (Klein 1977; Kruger 1979). Previous to aboriginal occupation lightning (West 1965; Bands 1977; Kruger 1979) and rock falls (Wicht 1945) were the most significant causes of fires in fynbos. Historically man is the major cause of veld fires (Fugler 1979). Hottentots burnt veld 2000 years or more ago (Scott 1970; Schweitzer and Scott 1973) to provide grazing for stock. Early Portuguese travellers saw bush fires while sailing off the Cape coast (Michell 1922): the burning custom was not introduced by European settlers. Early European settlers just copied this veld-burning practice. As they were not nomadic (as the Hottentots were) the veld was overgrazed (Fugler 1979).

Although fires have occurred in natural fynbos ecosystems for eons, little is known about the frequency of natural fires, especially during prehistorical and prehuman times (Gill and Groves 1980). Most authors have made inferences about burning regimes, but generally agree that natural fires occurred at intervals of 6 - 40 years (Kruger 1977c; Bands 1977). If they occurred more frequently many seed regenerating species would have disappeared, and although every effort was made to exclude fires from certain areas, few areas reach an age of 40 - 50 years. A period of four years should elapse to allow sufficient fuel to accumulate to sustain a fire (Van Wilgen 1982). Fires on the Outeniquas have occurred after such short periods (Le Roux 1969). Protection of veld from fires for periods longer than 30 years results in a decline in phytomass, and an accumulation

of vegetation and litter which can potentially burn. This factor is complicated in the Southern Cape, in mesic heaths which become dominated by *Gleichenia polypodioides*, and these communities burn with great difficulty, even when deliberate attempts are made to burn them (Taute, pers. comm.).

Wild fires have been reported for all seasons (Van Wilgen 1981b).

Fire seasons reflect the dominant influence of local climate (Kruger 1977c). Most fires occur in the summer (Bands 1977) but a greater incidence of winter fires occurs in the south coastal mountains than elsewhere (Kruger 1979) due to warm, desiccating winds, which increase fire hazard (Le Roux 1969).

Few data are available on fire regimes (seasonality, frequency, causes, intensity, size and distribution of fires) in fynbos mountain ecosystems. Horne (1981) analyzed data in the Groot Swartberg while Van Wilgen (1981b) analyzed fires and associated weather factors in mountain fynbos areas of the South-western Cape. This type of information is vital for an understanding of fire ecological problems and serves as a basis for the formulation of appropriate management systems. Management prescriptions are based on the natural fire regimes (Gill 1975) which occur in a particular mountain range.

In an attempt to ascertain the natural fire regime in the Outeniqua mountains, a study of fire reports submitted by staff of the Directorate of Forestry was undertaken. Reports covered the period 1906 to 1982, and provided data on a total of 436 fires. As reports are not always complete, only data on season, causes, areas burnt and

wind directions during fires are provided. The following data and figures are based on this study.

2.7.2 Causes and Sources of Recorded Fires

Table 2.12 summarizes the causes and sources of the recorded fires. Man-made fires accounted for 67,3% of the fires, 12,8% of the fires were of natural origin, while the causes of 19,9% of the fires are unknown. The most important cause of natural fires was lightning (96,4%). Burning accidents (14,7%), incendiarism (14,7%) and locomotives (14,9%) were the most important sources of ignition of fires caused by man. Fires caused by locomotives are restricted to Witfontein State Forest, as the railway line to Montague Pass passes through the plantations. Since the introduction of diesel locomotives in the early 1970s, fires within the railway reserve are restricted to burning articles discarded from passing trains. Accidental fires during burning operations result from fires jumping tracer belts and spot fires being carried into adjacent unburnt areas by wind.

TABLE 2.12 Incidence of fires with different causes,
Outeniqua Catchment Area, 1906-1982.

*Cause of fires	No. of fires reported	% of category	% of total
<u>Man-made fires</u>			
Smoking	40	13,7	9,2
Burning accidents	64	21,8	14,7
Locomotives	65	22,2	14,9
Incendiarism	64	21,8	14,7
Beehive robbing	17	5,8	3,9
Burning for grazing	9	3,2	2,1
Negligence	15	5,1	3,4
Campers	6	2,0	1,4
Children	10	3,4	2,3
Electric cables	3	1,0	0,7
Sub total	293	100,0	67,3
<u>Natural fires</u>			
Lightning	54	96,4	12,4
Falling rocks	2	3,6	0,4
	56	100,0	12,8
<u>Unknown cause</u>			
	87	100,0	19,9
Sub total	87	100,0	19,9
TOTAL	436		100,0

2.7.3 Season of Fires

Refer to Figs 2.7 and 2.9

Fires of unknown origin occur throughout the year with a peak during winter (July to August) and summer (January and February). Man-made fires predominate during summer (December to February) and winter (June to August).

The natural fire season seems to extend from early summer (December) to mid-autumn (April) as 64,2% of fires of natural origin occur during these five months. The reason for the low incidence of lightning fires in February is unknown. A smaller peak in lightning fires occurs in August and September.

For fire protection purposes it is important to know the season of the highest fire danger. Le Roux (1969) summarized fires in fynbos and in plantations on State Forests for the period 1911 to 1965. He found the periods December to March and June to September to be the most dangerous. During these periods 83,4% of all plantation and 86,2% of all veld fires occurred. My analysis (Table 2.13) agrees with Le Roux's data with 45,8% of all fires occurring during December to March and 33,5% of all fires from June to September. Although the frequency distribution of fires shows fire seasons they are not well defined.

Figure 2.7 Seasonal distribution of fires, 1906 to 1982.

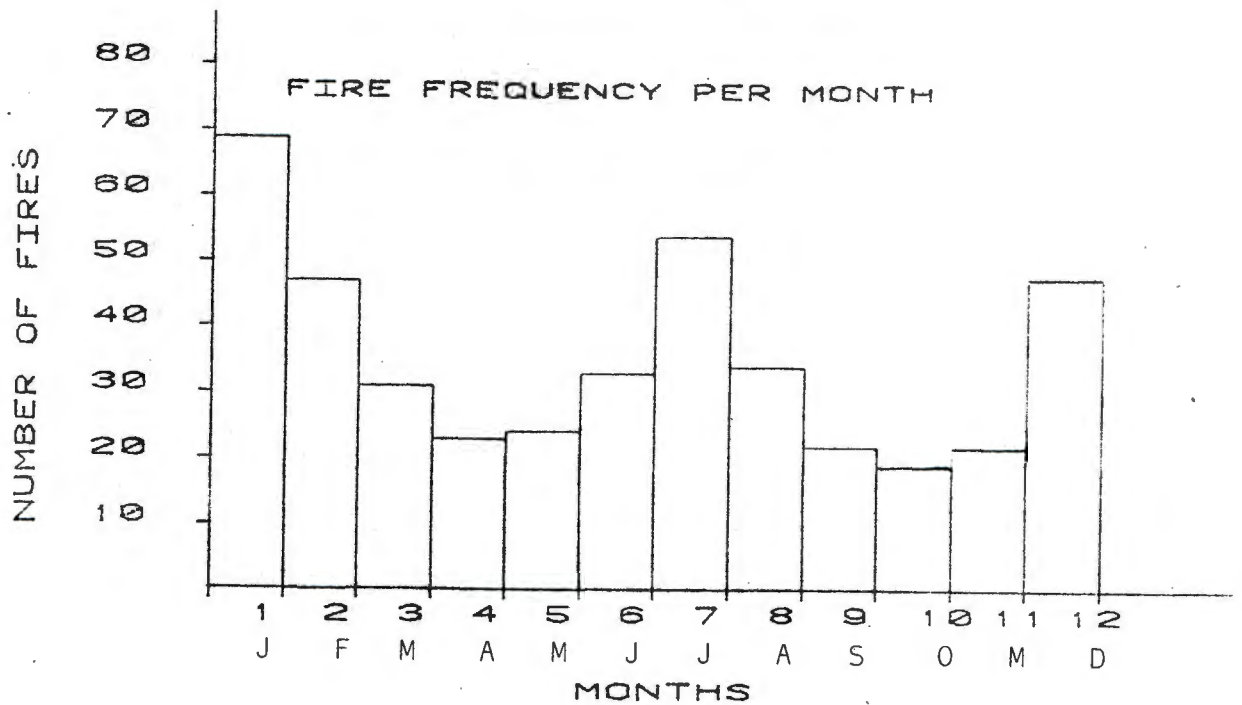
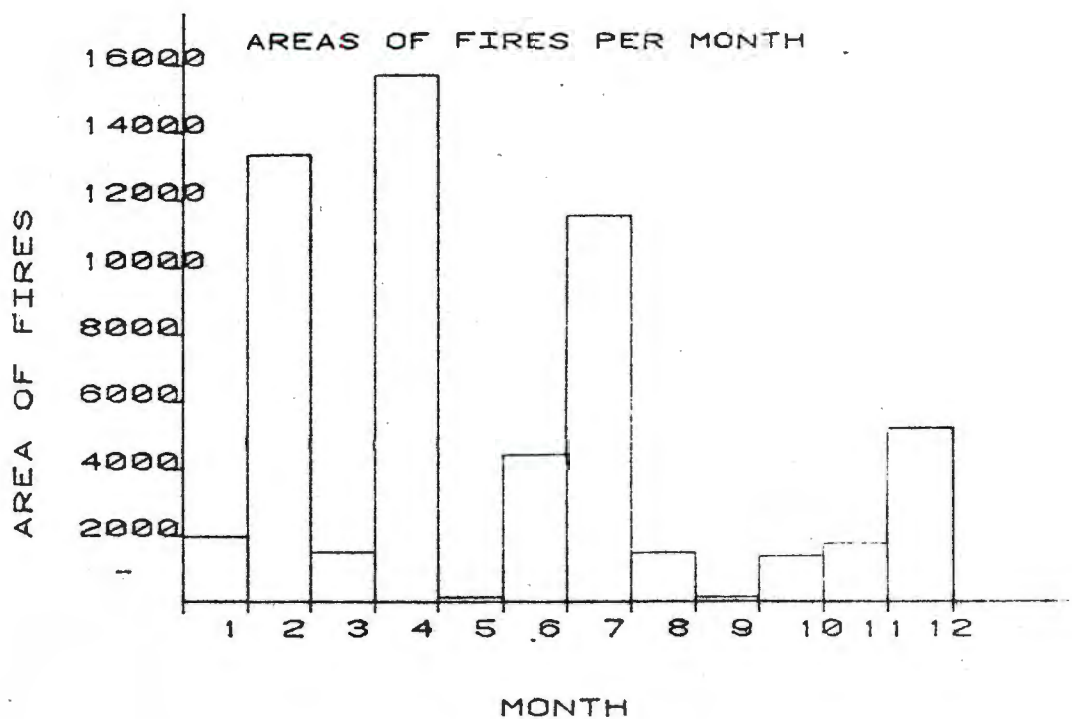


Figure 2.8 Areas of fires per month for all categories of fires, 1906 to 1982.



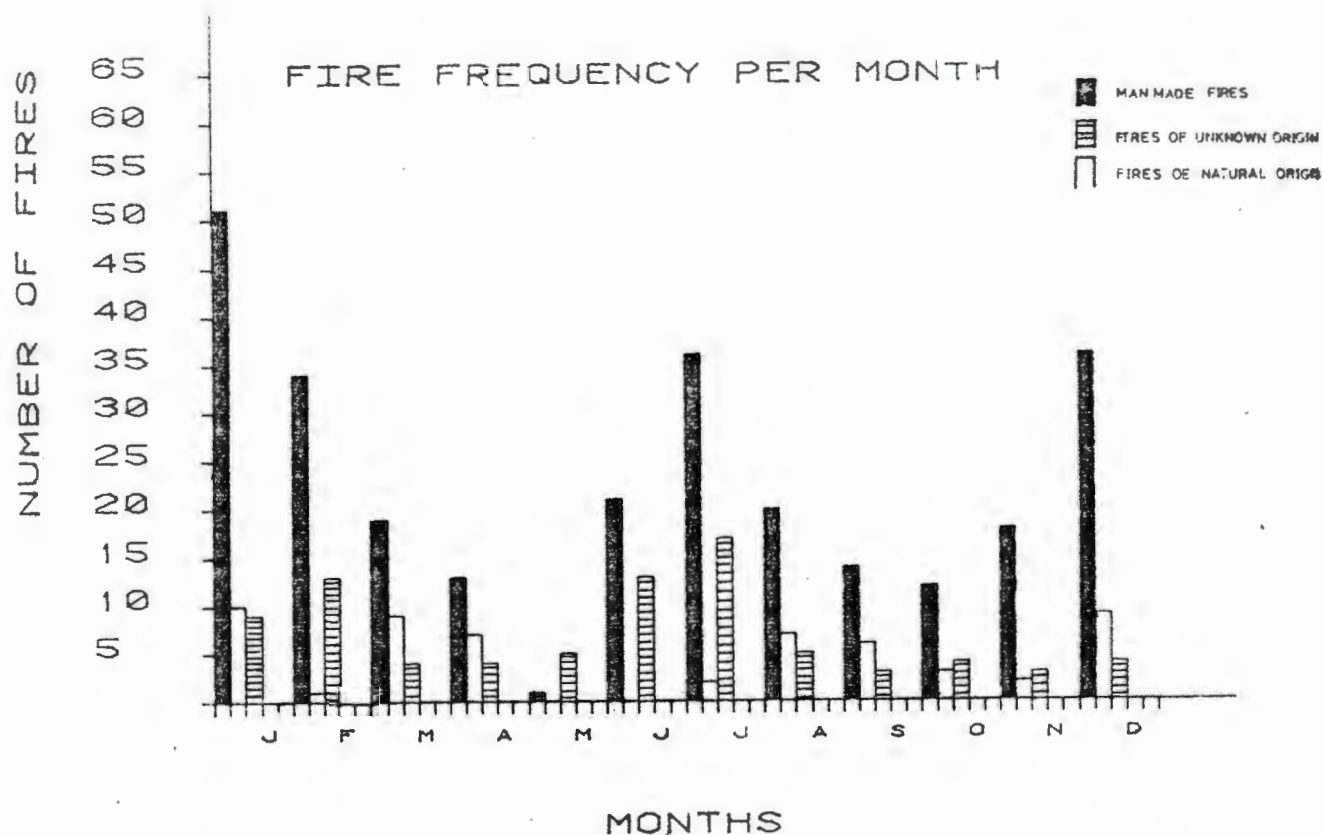


Figure 2.9 Seasonal distribution of fires of natural, man-made and unknown origins, 1906 to 1982.

Figure 2.10 Areas of fires per month for natural, man-made and unknown origins, 1906 to 1982.

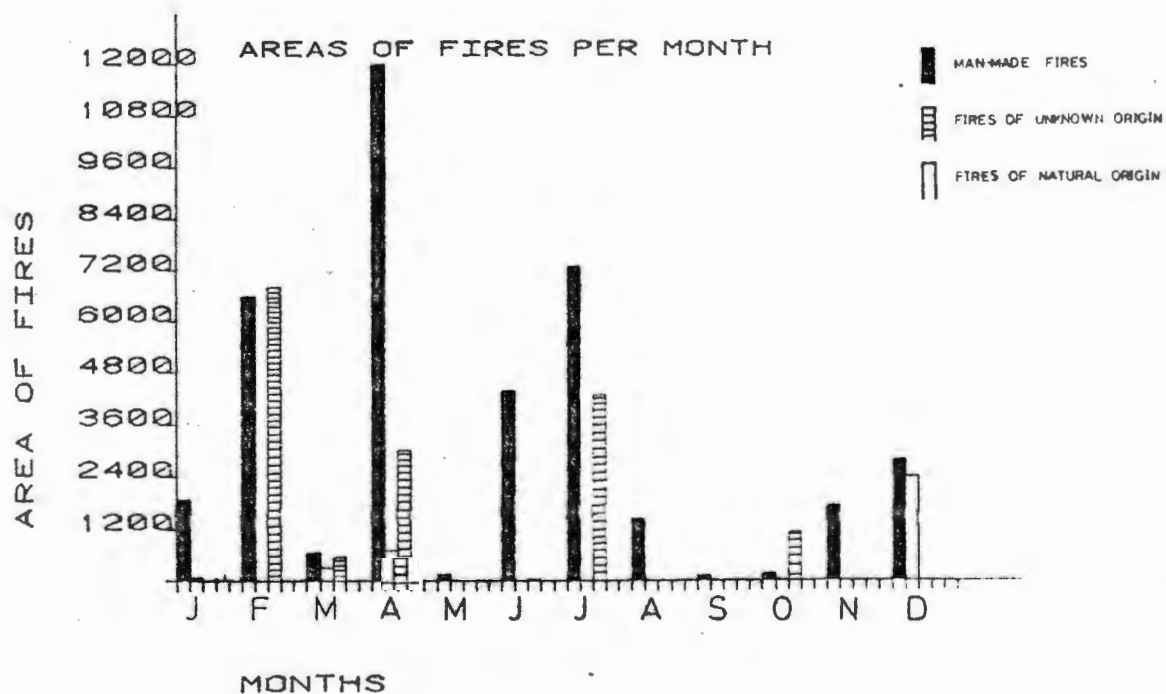


TABLE 2.13 Number of fires per month for man-made, natural and fires of unknown origin

Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
Man-made	50	33	18	13	18	20	25	19	13	12	17	35	283 (1)
Natural	10	1	9	7	0	0	2	7	6	3	2	9	56
Unknown	9	13	4	4	5	13	17	8	3	4	3	4	87
	69	47	31	24	23	33	54	34	22	19	22	48	426
% of total	16,2	11,0	7,3	5,6	5,4	7,7	12,7	7,9	5,2	4,5	5,2	11,3	

2.7.4 Size of Fires

Fynbos fires consumed 55 645,1 ha of veld: 94,9% of the total area burnt. Fires destroyed 2661 ha of plantations and 56,6 ha of indigenous forest, while 263,9 ha of unknown locality appeared in the reports. Figures 2.8 and 2.10 give the total areas per month and total areas burned for fires of different origins respectively. The largest areas burned in the summer months (2015,2 ha; 34,9%) as opposed to 17 422 (29,7%) in the winter months.

Although there were more man-made fires in summer (121 and 77 respectively), larger areas were burned during winter periods (11 232,0 and 13 117,5 ha respectively). Before the mid 1970s it was permissible to burn firebelts and compartments in the winter months. This resulted in many accidental fires. Berg wind conditions made fire-fighting very difficult, and some fires burnt very large areas of

fynbos and plantations. Prescribed burning in winter was prohibited in the mid-1970s. Since then no accidental fires resulting from prescribed burning have occurred in May and June.

A total of 35 649 ha was burned in natural fires. The largest areas were burned in December and January (28 854 ha; 19 fires) while no natural fires were recorded during May and June. Most lightning fires were extinguished by fire-fighting exercises (75,9%). Only 11 (20,4%) were extinguished naturally by rainfall. However, they only burned very small areas before being extinguished. One fire in April burned 780 ha before being extinguished by rain and forestry action, and another burned 36 ha before it was put out. Three fires were reported to have died naturally, but why they died was not indicated. It was reported in one of the latter cases that a change in wind direction extinguished the fire. The remaining two natural fires resulted from falling rocks. One, which occurred in a north westerly wind, was extinguished by forestry action after it had burned 5,67 ha. The fact that the majority of fires were extinguished makes it impossible to try and estimate the size of natural fires, which varied in size from 0,04 to 2000 ha (Directorate of Forestry records).

2.7.5 Fire Weather

The only weather data extracted from the fire reports was that of wind direction. Wind direction was recorded for 285 fires. As shown in Fig. 2.11, 12,5% of natural fires occurred during S.E. winds, 40,6%

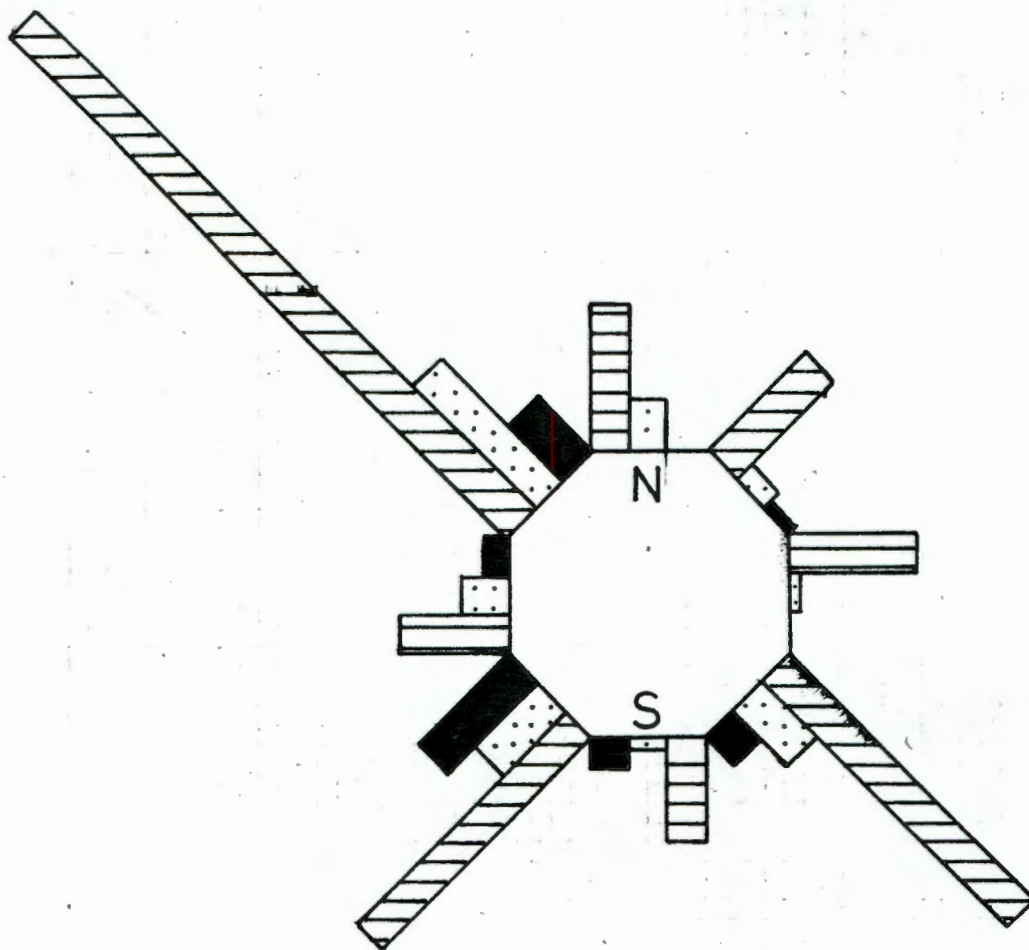
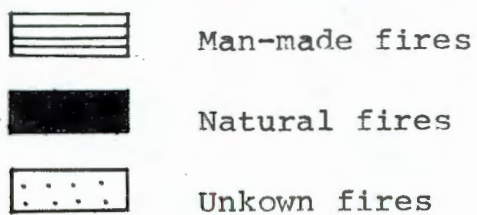


Figure 2.11 Prevailing wind direction during a reported 285 fires (1mm = 1 fire).



during S.W. winds, 25,0% during N.W. winds. Wind was variable during the remaining fires.

Dominant wind-direction during all fires was S.E. (17,6%), S.W. (15,2%) and N.W. (35,8%). The number of fires occurring during northerly winds reaches a peak in winter. Of 83 fires recorded, 65 (78,3%) occurred during the N.W. wind, the Berg wind. A peak in fires occurs during southerly winds in summer; 78 (75,7%) of all fires in summer. Of these 78 fires 34 (43,6%) occurred during S.W. winds and 38 (48,7%) occurred while the S.E. prevailed.

2.8 LAND-USE

Five land-use categories can be recognized in the Outeniqua Catchment Area, viz. water conservation, nature conservation, timber production, agricultural use and recreation.

a) Water conservation

At present this land-use is not actively pursued, as no management techniques have been applied to the fynbos to produce a sustained yield of water. The major purpose for the declaration of private land as a Mountain Catchment Area, is to actively manage the land for water conservation. Areas of the Swartberg and Langkloof State Forests on the northern slopes of the Outeniquas are being cleared of pines and

Hakea. This task will be completed within the next three years and forms part of an active water management programme.

b) Nature conservation

The Department of Environment Affairs' declared policy is the conservation of the natural ecosystem on the fynbos-covered areas of the State Forests (Garnett 1973). These areas form the State-owned portion of the Outeniqua Catchment Area.

c) Timber production

Timber production is of minor importance on private land on the northern slopes. The existing small plantations of *P. radiata* are being converted to cash crops due to long distances from markets (e.g. Searles Sawmill at Grootbrak River) and poor timber prices.

Future demands for timber may necessitate afforestation on the southern slopes within the study area, i.e. north of the existing plantations. Climatic conditions are well suited to afforestation, but edaphic factors (especially west of 22°30'E) are less favourable for afforestation (Owen 1971). This is principally due to chronic nutrient deficiencies in soils. In the Southern Cape low availability of phosphorus is a major constraint in commercial afforestation (Directorate of Forestry 1982).

d) Agricultural utilization

Little agricultural use is made of the mountain regions within the Outeniqua Catchment Area, and the majority of the privately-owned

mountain areas are not farmed (Tait 1967). The only form of use is grazing for small and large stock (on a limited scale), and the cultivation of certain *Protea* spp. (Dubell, pers. comm.). The nutritive value of natural fynbos pastures is low (Joubert *et al.* 1969).

Most grazing occurs on fallow wheatlands and Karooveld on northern foothills, and fallow wheatlands and coastal renosterveld (Muir 1929) on the southern slopes and foothills. No specific grazing pattern is followed. Short rotation burning (about every 6 years) is used in the Herbertsdale and Keurbooms valley areas in an attempt to improve the grazing as young fynbos has more palatable species than older fynbos. This practice has not met with much success and has destroyed the upper proteoid strata in many areas.

The many small river valleys (e.g. Safraan and Moeras Rivers) on the northern foothills are utilized for mixed farming. Farming activities follow a fixed pattern of small-scale irrigation (fruit trees, vegetables, hops), and extensive stock farming (Tait 1967). The greater portion of the production is yielded from these irrigation areas; non-arable lands have a low carrying capacity and contribute little to production. South of the mountains, in the vicinity of Mossel Bay, George and Knysna, stock farming is the most important source of income, and is alternated with dryland farming and annual and perennial crops. Vegetable farming occurs on a large scale in the George/Knysna area, but irrigation is essential for its success.

e) Recreation

Outdoor recreation on State Forests is restricted to low density,

dispersed and mainly primitive or extensive activities such as: rock climbing, hiking, mountaineering and walking (Van Zyl 1977).

In South Africa officially established hiking trails are a recent addition to the range of activities available to those who enjoy outdoor recreation. The National Hiking Way Board is vested with the powers (by the Forest Act in 1975) to plan, establish and manage a National Hiking Way through South Africa. The Outeniqua Hiking Trail is one of the trails opened by the Board (Hornby 1977).

The Outeniqua Trail is a nine day trail over its full length, but is also variable depending on one's capacity, time available or the weather. The best parts of the 148 km trail are the beginning, from Witfontein up Cradock's Peak into mountain fynbos (or from Saasveld), and the end from Millwood Goldfields through to Gouna and Deepwalls north of Knysna (Nixon 1982).

2.9 CONSERVATION STATUS OF THE OUTENIQUA CATCHMENT AREA

The Outeniqua mountains are losing their natural beauty due to extensive afforestation on the southern slopes, erection of radio masts, construction of roads and powerlines, and by the spread of exotic species of vegetation. However, there are still fairly large areas of the Outeniqua fynbos which should be managed for posterity, and should be seen as a resource in its own right, ranking in importance

to the agricultural and forestry activities in the mountains.

The status of much of the South African fauna and flora is under threat. The fynbos faces the greatest threat of all (Wildlife Society of Southern Africa 1980). Of a total flora of 6000 species, 1259 are in the threatened category, 36 are extinct, 89 endangered, 110 vulnerable, 278 rare, 184 indeterminate, and 562 of uncertain status. Thus 65% of South Africa's threatened plant species are found on less than 1% of the land. As the Cape flora is very large, care should be exercised in relating extinctions to man-made influences rather than to natural rates of evolutionary change.

Surveys of the conservation cover of South African and southern African terrestrial ecosystems has been undertaken by Edwards (1974) and Huntley (1978) respectively. Inadequacy of conservation of various ecosystems, including mountain fynbos is pointed out by these authors. Areas occupied by fynbos veldtypes and by permanent conservation areas within them appear in Table 2.14.

The conservation status of mountain fynbos is potentially good. A trend in its decreasing area must continue for sometime due to expanding agriculture and afforestation, and large new water storage and reticulation schemes. Surveys undertaken in fynbos have indicated local centres of **endemism** and diversity within both vascular flora and the thelepidopteran fauna. Such areas are of high conservation priority and indicate the need of a survey of threatened habitats rather than simply threatened species (Wildlife Society of Southern Africa 1980).

TABLE 2.14 Areas occupied by fynbos veld types and by permanent conservation areas in them (data after Edwards 1974)

Veld type	Coastal Macchia	Macchia	False Macchia	Strand- veld	Coastal renoster- veld
Total area (km ²)	8379	17 846	17 866	6308	14 591
Provincial and nature serves (km ²)	54	139	0,57	3,9	49
Unafforested State Forest lands (km ²)	128	2 857	3 761	60	76
% conserved	2,1	15,3	21,1	1,05	0,9

Noble and Hemens (1978) surveyed the conservation status of estuaries along the South African coast. The greater majority are degraded including those along the Southern Cape coast (e.g. Keurbooms estuary; Brownlie *et al.* 1982). The conservation of estuaries should receive urgent attention (Heydorn 1979), and the protection of the catchment areas on the Outeniquas is essential to achieve this aim.

CHAPTER 3

MANAGEMENT OBJECTIVES

3.1 SUMMARY OF OBJECTIVES

Management objectives for the Outeniqua Catchment Area can be stated in broad terms as follows (Wildlife Society of Southern Africa 1980; Directorate of Forestry 1981):

a) Primary objectives

Maintain essential ecological processes to ensure the existence and continued evolution of the greatest possible diversity of natural ecosystems and their components.

1. Conserve the water resources .

Conserve the catchments of the Outeniqua Catchment Area for the sustained yield of optimum quantities of high-quality water.

2. Preserve the soil mantle to ensure the maintenance of the productivity of a renewable natural resource .

Accelerated soil losses are to be prevented to ensure that optimum

conditions for plant growth and the present favourable hydrological characteristics of the catchments are maintained.

3. Maintain ecosystems in their natural state to ensure the conservation of the diversity of species, ecosystems and landscapes under natural rates of evolutionary change.

As there will be an increased use of the presently natural areas of mountain fynbos, there is a need to ensure the continued existence of viable representative areas of this biome.

Conserve genetic resources and diversity

4. Conserve genetic resources and diversity.

The highest possible level of genetic resources should be maintained. Avoid the loss of plant and animal species through human impact on ecosystems. Conditions should be maintained such that natural evolutionary processes can continue.

Preserve environmental quality and diversity

5. Preserve the integrity and wilderness character of the environment.

The aesthetic resources, amenity values, wild character and unique landforms of an area of natural beauty and diversity should be conserved.

Environmental research and monitoring services should be promoted.

6. Advance environmental research and monitoring.

These are two essential activities which provide data needed to refine and improve management techniques.

b) Secondary objectives

Promote educational and interpretive services

7. Development and maintenance of positive attitudes towards conservation of optimal environmental quality.

An informed public is essential for the achievement of the management objectives.

Provide outdoor recreation activities

8. Opportunities for resource-based outdoor recreation should be provided.

Recreation of nature at compatible scales with primary conservation objectives should be promoted.

3.2 SPECIFIC MANAGEMENT OBJECTIVES

Resource managers must clarify their aims, be explicit about them and relate them to time. Conservation of diversity should be the primary aim of management and is best achieved by conserving a wide range of habitats. Conservation should be concerned with providing for the future (Moore 1969).

Future planning will be subject to multiple-use principles (Ackermann 1976; De Villiers 1969) and is based on available ecological knowledge and pressures to use the Outeniqua Catchment Area's natural resources to the optimum. Application of multiple-use principles occurs by the application of primary and secondary aims on an aerial basis, taking the inherent characteristics of the specific area into consideration. Although the primary aim receives priority, consideration of secondary uses still carries a fairly large weight. Intensity of the primary aim is restricted to a level where no deterioration of any kind occurs in the environment (Seydack 1977). Secondary (subsidiary) aims depend on land-use priorities (Bands 1977), e.g. on State land nature conservation will enjoy equal status with water and soil conservation, except for areas where timber production is permitted. Multi-purpose management means that all relevant land-use types were identified for the Outeniquas and are realized according to the ecosystem's specific resource capacities. The following land-use types are applicable to the Outeniquas: water conservation, nature conservation, agricultural utilization, timber production, recreation and research.

Management of natural resources is aimless without unambiguous, specific goals. Ecological principles are used to achieve goals. A choice between objectives will ascertain whether management is necessary. If management is essential, then goals must explicitly state what management is to achieve. Goals are invariably bound to certain constraints (such as financial resources), and may have to meet certain minimum conditions (e.g. low silt loads in rivers). There are two major reasons why goals are not explicitly set as they should be

(Mentis 1980). Firstly, there is usually a choice between conflicting objectives (e.g. timber production and genetic diversity), and there may be constraints (e.g. funds, labour). Secondly, absence of an ideal reference point or the apparent need to await the outcome of a survey or research project may result in procrastination. Little, if none, of the Outeniqua fynbos is in a pristine condition. However, the lack of an ideal benchmark is no reason for not specifying ecological objectives on the basis of the most representative ecosystem that can be found. A choice based on the best available present knowledge can be made and if this proves to be inappropriate this should soon become apparent and another one might be considered. There is a danger in waiting for research to fill the gaps in our knowledge.

3.2.1 Water Conservation

The land-use category water conservation may be divided into four categories (Seydack 1982):

a) Direct regulation of water flow: entails the reduction of evapotranspiration by decreasing veld age through prescribed burning in an attempt to increase water availability (Van der Zel and Kruger 1975). This may entail exclusion of fire in flood-prone areas. Increased run-off augments the flow into large storage facilities (e.g. the Kammanassie and Ernest Robertson Dams).

b) Indirect water flow regulation: achieved by maintaining the water regulating capacity of the soil and vegetation layer which results in

preservation of the *status quo*. This maintains the redistribution of precipitation into surface run-off, evapotranspiration and infiltration. Infiltration augments subterranean water resources and is used to provide water for stock and domestic use from boreholes.

c) Water cycle protection: conservation of watersheds thus maintaining the present favourable, stable run-off patterns and flood control characteristics (Directorate of Forestry and Environmental Conservation 1981). Drastic environmental changes by land-use development such as cultivation, afforestation, overgrazing or construction (roads, dams) must be prevented. Maximum sustained run-off for local irrigation schemes is ensured.

d) Water quality preservation is achieved by preventing accelerated erosion and therefore silt loads, or pollution of water resources by any means. This includes the indiscriminate use of inorganic fertilizers or poisons for management purposes, and unacceptable levels of pollution by human and livestock wastes.

Water conservation is the primary objective on the Swartberg and Langkloof State Forests (northern slopes; Fig. 2.3), in the Moordkuilsrivier catchment and on private land in the proposed Mountain Catchment Area. Management should strive to achieve the above aims in these areas. It is of secondary importance on the remaining State land, run-off being a by-product of management for nature conservation and fire protection (prescribed burning) on fynbos catchments south of the watershed.

3.2.2 Nature Conservation

Greig (1979) provides evidence that the conservation of genetic variation should be the major consideration in the implementation of a nature conservation policy, for economic, ecological and aesthetic reasons. The survival of life in a dynamic world depends upon evolution, which in turn, is dependent on the existence of a full spectrum of genetic variation. Generally, nature conservation is looked upon as an activity concerned with protecting the past, rather than a positive activity concerned with providing for the future (Moore 1969). However, the aim of both nature and genetic conservation is to provide genetic building material for further speciation and diversification in the future. Nature conservation aims to conserve identifiable habitats, communities and species in the broad sense, while conservation of genetic pools is concerned with genetic differences which can only be surmised, but not identified. Conservation of biota is justified as they are useful to man and long-term conservation is only feasible in a state of continuing evolution. The object of nature conservation should be seen in the context of animal and plant communities, as well as general protection of the landscape, rather than on a focus on individual species. Motivation for the conservation of natural diversity is based on ethical and aesthetical considerations, scientific and potential economic values and social assets (i.e. recreation and education) of natural environments (Moore *loc. cit.*).

Miller (1980) can be quoted as a broad description of this management aim:

- a) "Maintain large areas as representative samples of each major biological region of the nation in its natural, unaltered state to ensure the continuity of the ecological processes, including animal migration and gene flow."
- b) "Maintain examples of the different characteristics of each type of natural community, landscape and land form to protect the representative as well as the unique diversity of the nation, particularly to ensure the role of natural diversity in the regulation of the environment."
- c) "Maintain all genetic materials as elements of natural communities, and avoid the loss of plant and animal species."
- d) "Provide facilities and opportunities in natural areas for purposes of formal and informal education, research and the study and monitoring of the environment."
- e) "Maintain and manage vast areas of land under flexible land-use methods, which conserve natural processes to ensure open options for future changes in land-use as well as the incorporation of new technologies, to meet new human requirements, and to indicate new conservation policies as research makes them available."

Nature conservation is the primary aim within the conservation zone on State Forests on the southern slopes and within existing and future nature reserves, the secondary objective within the fire control zone

on the southern slopes, private land within the proposed Mountain Catchment Area and on State land on the northern slopes.

3.2.3 Agricultural Utilization

Mountain catchment land in the Outeniqua Catchment Area is of low agricultural value (Tait 1967), and thus agricultural usage of these areas is limited. The management aim is only applicable to private land within the proposed mountain catchment area. The most important uses of mountain land are grazing by large and small stock, and cultivation of *Protea* spp. (e.g. *P. grandiceps*, *P. magnifica*) for the production of cut-flowers. Since the areas are too extensive, all privately-owned land in important catchment areas cannot be brought under control of the State by land purchase. The Mountain Catchment Areas Act is therefore applied to obtain control over the area where it is important that water resources receive a higher conservation status. The management aim is to allow agricultural usage to continue, but at the same time to realize water conservation aims, be it by preventing levels and types of land-use contrary to these aims or by active management involving State funds (e.g. control of problem plants).

3.2.4 Timber Production

It is one of the Directorate of Forestry's primary functions to produce sawtimber (Garnett 1973). To achieve this aim, extensive areas of pine and eucalyptus plantations have been established on the lower

southern slopes and foothills of the Outeniquas. Future demand for timber may necessitate afforestation of fairly extensive areas of the lower southern slopes.

Although climatic conditions are favourable (Owen 1971), edaphic conditions are generally poor (Grey, pers. comm.) for the establishment of plantations. Recent site analysis in the Southern Cape proved beyond doubt that dramatic improvements in tree growth can be obtained by use of fertilization as a standard silvicultural practice.

The aim of this land-use type is to designate suitable fynbos sites for future afforestation. These areas will be located north of the existing plantations on the southern foothills. New areas should only be afforested once existing plantation areas are utilized to their maximum potential by the improvement of management techniques. This essentially means the application of fertilizer regimes to improve the nutrient status of the impoverished soils. Site analysis should be an integral part of the planning process of new plantation areas to ensure that only suitable areas are afforested.

3.2.5 Recreation

The Directorate of Forestry has adopted a policy to provide recreation opportunities in mountain catchment areas (Ackerman 1976; Wicht 1976). Recreation seldom conflicts with other land-use types in the area. The types of outdoor recreation suited and provided by the mountains

(hiking, mountain climbing) do not conflict with other aims.

Apart from the Outeniqua Hiking Trail, few other recreational activities occur in the area. There are, however, a number of areas in the Outeniqua Catchment Area (e.g. Ruitersbos State forest) which could provide an important quasi-wilderness experience for hikers if trails were constructed in these areas. The aim of this land-use type is to provide for recreation in such areas. It will only apply to State land.

Prescribed burning is used to realize various management aims. A mixture of veld of different successional ages (mosaic) increases the scenic value by creating visual diversity, e.g. *Watsonias* and geophytes in young areas of veld, *Ericas* in medium-aged veld, and proteoid elements in older stands.

3.2.6 Research

Hydrological, fire ecological, and research on various forms of agricultural uses as a basis for future management practices is essential. Areas where research is an important management aim are classified in this land-use. At this stage little research is being undertaken on the Outeniquas. Paired-catchment experiments will shortly be initiated in the Moordkuilsrivier catchment, and will be classified under this land-use type (Kruger, pers. comm.).

Research is a secondary aim within other land-use types, e.g. prescribed burning can provide valuable data on fire ecology (Jordaan 1972).

CHAPTER 4

THE OUTENIQUA MOUNTAIN CATCHMENT AREA: REALIZATION OF WATER CONSERVATION AIMS

4.1 HISTORICAL PERSPECTIVE

Early settlers copied the practice of burning fynbos for grazing stock from the Hottentots, but as they were not nomadic the veld soon deteriorated due to overgrazing: the introduction of goats accelerated the process (Fugler 1979). The various Governments of the Cape of Good Hope (possibly due to a background of European agricultural practices), made a stout effort to discourage veld-burning, issuing many "placaats" prohibiting veld-burning (Scott 1970; Van der Zel and Kruger 1975). Opposition to indiscriminate burning and grazing of veld, resulting in veld deterioration and soil erosion gained momentum towards the end of the eighteenth century (Le Roux 1966). However, it was only at the commencement of the twentieth century that a concerted effort was launched against uncontrolled fires, and numerous authors expressed their concern about the destruction of the veld (e.g. Bews 1918;

Michell 1922; Adamson 1927; Phillips 1938; Wicht 1945). These opinions, based on the combined effects of fire and unwise grazing, became entrenched during the first half of the twentieth century. It influenced policy and legislation, and determined conservation applied in mountain ecosystems. The Irrigation and Water Conservation Act of 1912 provided for the expropriation of land for catchment protection, while the Forest Act of 1913 made provision to obtain land for erosion control (Seydack 1982).

Reports of various committees and commissions during the second quarter of the twentieth century indicated considerable interest in the conservation of catchments and mountain veld. The State pursued a policy of total fire protection from the 1930s, based largely on the deterioration of catchment areas. During a 1934 Parliamentary session a motion was accepted to investigate the causes of decreased run-off (Seydack 1982). Hydrological research was initiated at Jonkershoek (Wicht 1943). The appointment of an Interdepartmental Committee produced recommendations which were incorporated in various Acts: the Forest and Veld Conservation Act, 13 of 1941, the Soil Conservation Act 45 of 1946 and the Natural Resources Development Act, 51 of 1947. The Soil Conservation Act made provision for the creation of fire protection districts for private mountain catchment land, which were managed by Fire Protection Committees (Bands 1977). The first committees were appointed in 1949 (Bands 1977) and large tracts of mountain catchment land were subject to a network of firebreaks and roads in order to implement the total protection policy (Le Roux 1966). The extent of the practice of burning for grazing declined.

The Department of Forestry provided an exception in the Southern Cape in 1948 as a measure for protection of plantations and indigenous forests (Le Roux 1966).

In 1952 the Soil Conservation Board appointed an Interdepartmental fact-finding committee to investigate the problems relating to the conservation of mountain catchments. A comprehensive report resulted (Ross 1961) making recommendations concerning the protection of important, hydrologically sensitive mountain catchments, fire protection, prevention of grazing and recommendations that land be acquired on a large scale for this purpose (Van der Zel 1981). However, in spite of concerted efforts, it was not successful in preventing catchments burning periodically, a policy which proved very difficult to execute.

Experience in applying extensive, total, fire protection (favoured by the fire protection committees) and the fact that fire began to be recognized as a normal ecological factor in fynbos (Wicht 1945; Le Roux 1966), substantiated by studies of different effects of fynbos of different ages on run-off (Rycroft 1947; Wicht and Banks 1963) indicated that the policy of total protection was undesirable.

A policy of controlled burning could not then be fully implemented because of the uncertainty about fire frequency and season (De Villiers 1963). In 1968 the Department of Forestry recognized the need to apply controlled burning (Malherbe 1968), not only for fire protection, but also for water and nature conservation. Guidelines for an official prescribed burning regime were laid down in the same year, with the aim of reducing evapotranspiration loss of water by lowering

the average age of the veld. Private catchments were still subject to the Soil Conservation Act (Fire Protection Committees). In order to promote a uniform approach and coordinated action, the Government centralized the task of protecting and managing mountain catchments (State or private ownership) and with effect from April 1970 entrusted the task to the Department of Forestry (Kruger *et al.* 1980).

4.2 PROVISIONS OF THE MOUNTAIN CATCHMENT AREAS ACT, NO. 63 OF 1970

Refer to Appendix 1.

The Mountain Catchment Areas Act, No. 63 of 1970, as amended, was promulgated to provide for this centralized control (Rabie 1976). The Act confers the necessary statutory powers to the Department of Environment Affairs to manage privately-owned mountain catchment areas, and make provision for the expenditure of State funds to realize management objectives. Private land, where water resource matters are of importance, can be declared and thereby be brought under control of the State so that multiple-purpose management can be initiated. A legal basis is therefore provided for the achievement of land-use patterns compatible with a sustained flow of silt-free water (Ackermann 1976).

The Minister (of Environment Affairs) may, by notice in the Government Gazette, define any area (a map and boundary description are supplied)

and declare that area to be a Mountain Catchment Area, in terms of Section 2 of the Act (Rabie 1976; Kruger *et al.* 1980).

The Minister may declare (Section 3) directions to be applicable to any owner or occupier of land within any mountain catchment area relating to the conservation, use, management and control of such land, the prevention of soil erosion, the protection and treatment of natural vegetation and the destruction of intruding vegetation. Although Section 2 of the Act empowers the Minister to declare private land as catchment areas, he does not act autocratically in this connection. He acts on the advice of an Interdepartmental committee appointed for this purpose. The committee consists of representatives of the Departments of Environment Affairs and Agriculture. The committee is permitted to co-opt locally interested parties: organized agriculture (e.g. agricultural unions) and land owners directly involved with the water supplies of the particular catchment area.

The principal objective of the Act, as it is applied to private land, is the conservation of water resources, that is to ensure a sustained, optimum yield of silt-free, unpolluted water on a perennial basis from the catchment areas (Kruger *et al.* 1980). Any form of land-use which does not conflict with the goal of the Act is permissible. However, much of the mountain is of little agricultural worth (Tait 1967), and few forms of intensive land-use are encountered within the catchment area. Regulation is therefore directed at limiting the extent of such activities as grazing and short rotation burning to provide grazing for stock, and of applying sound soil conservation measures where these uses are practised.

4.3 WATER CONSERVATION ON PRIVATE LAND ON THE OUTENIQUA CATCHMENT AREA

A perennial supply of water is essential for irrigation of orchards, vineyards, vegetables and planted pastures in the Little Karoo, on farms adjacent to the Outeniqua and Langkloof Mountains. Perennial streams have their source in sponge areas on the crest of the Outeniquas, and flow northwards across the Little Karoo to discharge into the Kammanassie River, or westward to discharge into the Gouritz River. Streams draining the eastern Outeniqua mountain discharge into the Keurbooms River. A large number of dams have been constructed to tap the perennial water from these streams, to irrigate croplands at the foot of these mountains.

The fynbos on the northern slopes of the mountains is heavily infested with *Hakea sericea* and *Pinus pinaster*, which results in an increased fire hazard for plantations on the southern slopes during extreme fire hazard conditions, when Berg winds blow for extended periods.

The catchments in the Outeniqua Catchment Area east of the Prince Alfred's Pass have been burned at such regular intervals to provide grazing for cattle, that the original waboomveld has been reduced to a community dominated by short grasses: only scattered patches of *Protea nitida* remain. All of the streams are choked by *Acacia mearnsii* (black wattle) which will decrease the streamflow of the Keurbooms River, the source of water for irrigation and domestic use in the Plettenberg Bay area.

Irrigation on the southern slopes between the Gouritz and Robinson's Pass is predominantly limited to the flood plain of the Langtouri-rivier, in the vicinity of Herbertsdale. Many of the streams in this catchment are infested with black wattle. Short rotation burning is practised on these slopes to provide grazing for cattle. The upper proteoid stratum has been destroyed by these fires over fairly large areas.

Conservation of these catchments is therefore of importance for the regional economy of the Southern Cape. Sound management principles should be formulated to realize the water conservation potential of these catchments. Although legislation does not provide for nature conservation as a land-use goal on private land there are large unused areas of land and, if the owners are in agreement, catchment management based on nature conservation principles could be initiated (Kruger *et al.* 1980).

To realize the aims of water conservation as a land-use, the provisions of the Mountain Catchment Areas Act were applied to the areas of private land on the Outeniqua and Langkloof mountains. Private land, where water matters are of importance, should be brought under control of the State (the Directorate of Forestry) so that multiple-purpose management can be initiated. Before management can be applied to private catchment areas they should be declared a Mountain Catchment Area.

An accurate boundary description of the proposed Mountain Catchment

Area is required so that the Minister may, by notice in the Government Gazette, define the area and declare the area to be a mountain catchment area under the powers vested in him by Section 2 of the Mountain Catchment Areas Act, as amended.

I represented the Department of Environment Affairs on the Inter-departmental Committee and undertook the task of ascertaining the desirability of determining whether the private land on the above-mentioned mountains should be declared a mountain catchment area.

A policy statement concerning the selection and demarcation of mountain catchment areas in private ownership was issued under the cover of the Secretary for Forestry's communication 21/3/4 of 22 December 1970 and 10/3/3/25 of 17 September 1971. Past experience during boundary determination in the Western and Southern Cape showed that if the criteria in the policy statement were strictly followed an artificial boundary resulted, based on farm boundaries, rather than ecological principles.

The following criteria were used during the selection and demarcation of the boundaries:

a) The importance of the mountain catchment area as a source of water, for both present and future use, is the most important criterion for the selection of mountain catchment areas by virtue of the Act. For the purpose of the study a mountain catchment area was "taken to include the main mass of a mountain range (in this case the

Outeniqua and Langkloof Mountains), together with any spurs or connected outliers, above the general level of the surrounding plains. It therefore comprises the crest or watershed, plateaux, slopes, foothills and connecting valleys" (Ross 1961). Kruger *et al.* (1980) define a mountain catchment area as the mountain lands exceeding 300 m elevation in the constant rainfall zones.

Table 4.1 indicates the relationship between rainfall and run-off, the percentage run-off, and corresponding water yield for a mean catchment size of 2000 ha (Seydack and Odendaal 1980).

TABLE 4.1 Relationship between rainfall and run-off for a mean catchment size of 2000 ha (after Seydack and Odendaal 1980).

MAP (mm)	MAR (mm)	% MAR MAP	Expected water yield for a 2000 ha catchment (cumecs)
225	2	1	0,00 1
295	5	2	0,00 3
370	10	3	0,00 6
455	20	4	0,013
610	50	8	0,032
760	100	13	0,063
940	200	21	0,127
1255	500	40	0,317

A substantial run-off percentage only occurs from 600 mm annual rainfall. A water yield of 0,01 cumecs is required before it is worthwhile to irrigate from a water source. It can thus be concluded that regions with rainfall lower than 400 mm do not provide a substantial contribution to run-off, and only provide a marginal contribution to recharge of subterranean aquifers. Areas with a mean annual rainfall of 450 mm are predominantly covered with arid fynbos or Karoo veld types. These communities are situated on rocky substrata and have a low canopy cover. It is doubtful whether increased run-off will result from the manipulation of vegetation under such conditions (Seydack and Odendaal 1980).

These criteria will result in catchments, in which important rivers have their origin (water used to a high degree by various users), being included in the mountain catchment area.

b) A major consideration is the importance of the mountain areas with low agricultural potential but a high water production potential, as existing or potential sources of water for agricultural, domestic and industrial use. The relative importance of the run-off in these catchments is the determining factor for the inclusion of these areas.

c) In mountainous areas where water yield is not of cardinal importance, but where the vegetation has already deteriorated to such an extent that some measures are needed to prevent erosion and further

degradation of the vegetation, should be considered. In the case of the Outeniqua Catchment Area the areas east of the Prince Alfred's Pass and the catchments immediately to the east of the Gouritz River fall into this category.

d) Although rainfall has a large influence on the run-off and water production potential of catchments on the Cape Supergroup (quartzites and sandstones), it is not necessarily the deciding factor to be used to differentiate between land to be included in a mountain catchment area and that which is going to be excluded. There are a number of areas with a relatively low rainfall, but where run-off from such a region is of the utmost importance for the farmers who are entirely dependent on a perennial flow of water. The irrigated orchards on the northern foothills between the Gouritz and Moeras Rivers fall in this category.

e) Exotic vegetation, such as *Acacia* and black wattle invade indigenous vegetation and form dense stands. Although there are no research results to substantiate the supposition that these plants, due to their high biomass, utilize larger quantities of water than the natural fynbos, it is generally accepted that run-off from such areas must be significantly reduced. This factor must be given consideration when deciding on the areas to be included in a mountain catchment area.

4.4 DETERMINATION OF A MOUNTAIN CATCHMENT AREA

Bearing the above-mentioned criteria and policy in mind, with the aid of topographical and rainfall maps, and the Ross Report (Ross 1961) a mountain catchment area was identified on private land on the Outeniqua and Langkloof Mountains and outlined on 1:250 000 topocadastral sheets. Boundaries of catchments were transformed onto aerial photographs. The boundary was altered to exclude all identifiable forms of agricultural activities, such as orchards, from the proposed catchment. Amended boundaries were then delineated on 1:50 000 topocadastral sheets, the basic mapping scale used in catchment management exercises. Existing farm boundaries, surveyors' beacons, natural divisions (such as rivers, roads, cliffs and watersheds), divisions between agricultural and natural veld, and internal farm fences were used to designate boundaries. This exercise was undertaken theoretically in the office prior to any field surveys so that I had a basic grounding of the location and size of the area, regional hydrology, topography, geology and vegetation of the private catchments.

A water and a land-use survey was conducted on private land within, and adjacent to, the proposed catchment area in order to check the validity of the theoretical boundaries on the ground.

Agricultural activities, water resources, irrigation schemes and the conservation status of each sub-catchment was determined. These data were used to determine important catchment areas, which should receive

a high conservation status by their declaration as a mountain catchment area. The boundaries were modified on the 1:50 000 sheets where the field data indicated this to be necessary. The boundary for the proposed Outeniqua Catchment Area is indicated in Figs 2.2 and 2.3. This boundary will appear in the form of an appended sketch map, together with a beacon to beacon description, in a future Government Gazette. The Minister will declare the area a Mountain Catchment Area by virtue of the power vested in him, according to Section 2 of the Act.

Provisions of the Act influence private property included in a mountain catchment area in a number of ways. If, due to any direction, limitations are placed on the purposes for which the land may be used, the owners or occupiers of the land shall be paid compensation in respect of patrimonial loss suffered by them (Section 4(1)). Land within a mountain catchment area, upon which in terms of any direction, no farming shall be carried out shall be exempt from taxes imposed by a local authority on the value of immoveable property (Section 5(1)). It is therefore imperative that all land owners whose land is to be included in a mountain catchment area be notified of the State's intention. The full implications of the proposed proclamation of a mountain catchment area, and how their properties may be affected, should be explained to each owner. Provided the overall efficacy of the boundary is not affected, the boundary line should be modified to accommodate reasonable requests of the property owners.

4.5 DISCUSSION

A major objective of the management of the Outeniqua Catchment Area is that of the conservation of the natural water resources of the catchment areas on the Outeniqua and Langkloof mountains. The declaration of a mountain catchment area to include these catchment areas is considered the most objective method to achieve these aims. Most land owners consider their mountain land as important catchment areas to supply the water needed for the irrigation of croplands, and realize the threat exotic vegetation poses to the water resources and to conservation status of the Outeniqua fynbos.

Although there are essential differences in the scope of land-use and objectives of management of State and private land, the two categories of land-use are located on the same mountain range. The categories form a convenient ecological unit and are therefore treated as a whole in planning.

CHAPTER 5

MANAGEMENT POLICY

5.1 MANAGEMENT SUBDIVISION

5.1.1 Management Zonation

An efficient classification system is an essential foundation for planning. The purpose of a classification system is to allow land and its usage within the Outeniqua Catchment Area to be assessed. The classification system used here is based on Van Gadow and Seydack (1979), which realizes land-use types through a number of objectives, aimed at meeting the demands of multiple-purpose planning.

Once the Outeniqua Catchment Area has been subdivided, according to land-use and management objectives (management zones), it is further subdivided into management units or compartments taking advantage of natural topographical features where possible (Bands 1977; Directorate of Forestry 1981).

Management zonation is based on various forms of application of fire

management (Seydack 1982). For the purpose of this study management zones are defined as regions in which a single, specific, or a number of complementary management aims are striven for and which are subject to a uniform management approach (Seydack and Horne 1980).

Specific management principles must be applied to realize the management aims discussed in Chapter 3. The designation of specific land-use types in the Outeniquas gives rise to four management zones: water conservation zone, restricted management zone, conservation zone and fire control zone.

5.1.1.1 Water conservation zone

a) Management aims

The primary land-use is water conservation (active manipulation of run-off) with secondary aims of nature conservation, recreation and agricultural utilization (grazing, production of wild flowers).

b) Aerial designation

The following areas will fall into this management zone:

- i) Areas which are important for water yield (sufficient run-off and substantial utilization of water). Areas delegated to this zone have a relatively high rainfall which is partially due to an orographic effect on the high mountain ranges (Phillips 1931). Maximum perennial run-off from these streams is important for irrigation (Tait 1967), while

surplus water is important for storage in dams (Claasen 1978).

- ii) Areas, where according to our present knowledge (Van der Zel and Kruger 1975), water yield will be increased by prescribed burning and due to the dependency of the farming community deliberate veld management in this connection is warranted (e.g. Wicht 1971c).
- iii) Areas are included where systematic burning is necessary for effective control of invasive plants (Kruger 1977a; Fenn 1979).

General policy in respect to nature conservation and the specific presence of certain scarce plant species (Bond, pers. comm.) makes nature conservation as a secondary objective applicable in this zone.

c) Management designation

The proposed Outeniqua Mountain Catchment Area, the Moordkuilsrivier catchment (Seydack and Horne 1980), the portions of Swartberg and Langkloof State Forests and the land controlled by the Department of Agriculture on the northern slopes are allocated to the water conservation zone.

d) Management subdivision

For management purposes, the zone will be divided into compartments.

e) Management

The appropriate management is scheduled burning on a specific rotation.

5.1.1.2 Restricted management zone

a) Management aims

It is not the State's intention to restrict owners in the use of private property. Due to imperfect knowledge of the effects of various land-use practices on the hydrology of catchment areas, the approach to what is tolerated must be conservative (Hoekstra and Crabtree 1979). Diverse management aims will be realized in this zone, e.g. flower picking, cultivation of proteas, grazing and other agricultural uses.

b) Management designation

All unutilized private land within the proposed Mountain Catchment Area, which has not been allocated to the water conservation zone, i.e. where water conservation is not of primary importance. Any land withdrawn from the water conservation zone, e.g. to establish proteas, will be allocated to this zone.

c) Management subdivision

Areas excised from the water conservation zone are managed at the private land owners discretion, and therefore no specific subdivision can be prescribed. In the case of grazing areas subdivision would be into camps.

d) Management

Any management approach followed by land owners is subject to restrictions deemed necessary under the Mountain Catchment Areas Act. Each land owner will be permitted to follow his own management approach, but in consultation with the Department of Environment Affairs. This approach allows maximum flexibility for private utilization of particular areas, is practical for the local Departmental official, but still provides the necessary framework for control in terms of the Act. No active management is envisaged by the Department.

Most land uses necessitate removal of natural vegetation and exposure of soil to wind and impact of rain and running water, and reduction of infiltration due to adverse changes in surface structure. They are therefore prohibited. Other activities are permissible but they must not result in a reduction of the infiltration rate or increased erosion rate, an increased silt load of streams under conditions of normal or spate flow or an increase in the level of dissolved salts or other inorganic compounds or undesirable organisms.

5.1.1.3 Fire control zone

a) Management aim

The primary management aim is:

- i) Fire protection of the plantations on the southern foothills (Le Roux 1969).
- ii) To prevent wild fires entering the Mountain Catchment Area

from neighbouring undeclared private land and thus disrupting the burning regime.

- iii) To prevent accidental fires (e.g. caused by lightning) which originated in the Mountain Catchment Area crossing the boundary and causing damage on neighbouring private land.

Secondary aims include water conservation, nature conservation, recreation and research.

b) Aerial designation and management subdivision

This zone is subdivided into firebreaks and compartments. A double rotation firebelt protects the plantations from fires originating in the fynbos on the southern slopes. A similar fire belt has been located on the watershed of the Outeniqua mountains, to prevent fires originating on the northern slopes threatening the plantations. A fire protection committee undertakes the periodic burning of a fire belt which was established along the foot of the northern slopes to protect agricultural land from wild fires originating on the northern slopes.

A narrow strip of fynbos, north of the plantations, has been subdivided into compartments, which are burned periodically to provide protection for the plantations. Fynbos areas designated for future afforestation are included in this zone. The aim is to reserve suitable sites for future afforestation, based on comprehensive site analysis.

c) Management

It involves extinguishing, or restricting to the smallest possible size, any unscheduled fire which starts in the Mountain Catchment Area. The creation of a mosaic of fynbos of different ages, by conducting a prescribed burning regime in the compartments designated for fire control purposes, will much reduce the size of any fire originating in this area. The task of suppressing such fires will be made much easier.

Provisions in Sections 8(2)(b) and 12 of the Mountain Catchment Areas Act and Section 13(1)(a) of the Forest Act are adequate lawful support for constructing continuous firebreaks along the boundary of the Mountain Catchment Area.

5.1.1.4 Nature conservation zone

a) Management aims

The primary objective is the preservation of the genetic diversity of the Outeniqua fynbos. Secondary objectives are water conservation, fire protection, recreation and research.

b) Aerial designation

Two categories are involved:

i) Fynbos areas

Fynbos areas where nature conservation is the primary objective but which will not have the legal status of

nature reserves. Areas in this zone include the extensive areas between the fire control zone and the crest of the mountain, smaller fynbos patches along rivers (not suitable for afforestation), as well as fynbos islands in the indigenous forest (Cameron 1980).

ii) Nature Reserves

Existing nature reserves (Ysternek Nature Reserve: Government Notice No. 2241, dd 2 April 1972), proposed nature reserves (Attakwas Nature Reserve: Directorate of Forestry internal files A20/2/3 dd 24 April 1978 and A20/2/3 dd 20 June 1982) and nature reserves whose proposals are in preparation (e.g. Gouldveld State Forest) are allocated to this zone.

c) Subdivision

This zone will be subdivided into compartments for management purposes.

d) Management

The appropriate management for this zone is scheduled burning on a specific rotation.

5.1.2 Management Units

Each zone (excluding the restricted management zone) is subdivided into compartments (using 1:50 000 topocadastral maps and aerial photographs),

selected as areas of uniform terrain, climate and soils, or uniform patterns of these (Directorate of Forestry 1981). Compartments are separated by boundaries formed by natural features, such as streams or ridges (Bands 1977). Where no natural feature is suitably placed it may be necessary to construct well-made, contoured paths (Hornby 1977) as a compartment boundary. Sharp ridges and river courses blend in with the landscape. Compartments should be chosen in such a way that they can be burned with a minimum of tracers (Britton 1978). Compartment boundaries on ridges have the advantage that the construction of tracer belts is cheaper (vegetation is less dense) and prescribed burning can be conducted more safely. However, in a number of cases river courses will have to be used. This has the advantage that mountain forests are well-protected from fires, but the river course can be precipitous and unsafe. Forests have maintained their status over the ages in spite of periodic fires (Moll 1981), and it should not be necessary to give the forests special protection by the construction of tracer belts: they should rather be protected by choice of weather conditions during burning, or burning away from forests.

The following factors should be considered when deciding on the subdivision of a zone into compartments: practicability of uniform management, risk of exposure to erosion or other environmental degradation, undesirable concentrations of stock or wildlife, security from uncontrolled fires, diversification of habitat, wildlife cover and food sources (Bigalke 1974), maintenance of aesthetic values and provision for sensitive and special communities and species.

Compartments are permanent management units, and thus compartment size should be equated to optimal scale of management. Options as to the scale of management may be provided by the combination of two or more compartments for a single treatment rather than initial demarcation of larger less flexible units. An important consideration on the southern slopes is the creation of veld of varying succession of ages (a mosaic) to minimize the probability of large runaway fires endangering the plantations. Another important factor is the most efficient use of labour and other resources during burning operations. The extent of weed infestation and the resultant load imposed by the eradication programme will influence the size (Bands 1977).

Direct management costs are largely a function of compartment perimeters, since expenses incurred occur in the construction of tracer belts. The lower the ratio of perimeter to area (i.e. the larger the compartment) the lower the unit cost of management (Kruger 1977b). Van Wilgen (1981b) indicated that it is uneconomical to have any compartment smaller than 200 ha, and compartments over 1000 ha will not lead to any appreciable reduction in costs. The optimum area in the Western Cape would thus be in the region of 750 - 1000 ha. No analysis of the costs of prescribed burning have been undertaken for the Southern Cape, to determine the optimum economic size of compartments. Taking practical and ecological factors into consideration, the same size was found to be practical for the Southern Cape. However, field staff prefer slightly small compartment sizes on the southern slopes as the vegetation is very dense and produces a high biomass over a relatively short period. Compartment boundaries

should be mapped by ground checks. Exact boundaries in the field will depend on conditions during burning. Compartment registers are compiled and activities, such as prescribed burning and eradication of exotic vegetation, are recorded. Prescriptions for compartments will include details of recreation, minimum standards of trails, special measures for species requiring particular treatment and so on.

5.2 GENERAL BURNING PRESCRIPTIONS

5.2.1 Ecological Principles in Prescribed Burning

Fire is related directly or indirectly to most management objectives in the Outeniqua Catchment Area. It is an ecological factor controlling diversity in fynbos (Bands 1977; Van Wilgen 1980) and can be utilized for water flow regulation (Van der Zel and Kruger 1975), habitat improvement for wildlife (Ackermann 1976; Bigalke 1974), fire protection (Le Roux 1969; Ahlgren & Kozłowski 1974) and invasive plant control (Seydack 1977; Fenn 1979; Milton 1980b). Fire management is central to mountain catchment management as it is both an ecological factor and a tool of resource manipulation (Seydack 1982).

Opinions as to long-lasting effects of fire on fynbos are conflicting, and as yet have not been verified by research. On the basis of experiments reported in the literature, observations and discussions with field and research personnel, several well-founded hypothesis can

be stated with respect to the use of fire as a management tool in fynbos. Prescribed burning as a management tool, involves purposefully igniting fires in selected places under conditions of weather and fuel moisture to enable the spread of flames and the intensity of heat to accomplish certain planned effects (Kayall 1966; Biswell 1974). Accepting that fire is a normal environmental factor in fynbos, immediate effects on vegetation depend on fire intensity, while long-term effects depend on fire frequency (rotation) and season of occurrence. These three variables are used to formulate specific fire regimes (Gill 1975).

a) Fire intensity

Little is known about the intensity of fires in fynbos ecosystems. Accepting that prescribed burning is applied during the correct season and at the correct frequency, it can be presumed that the resulting fire intensity will be similar to fires which occur naturally as a result of lightning. There is little practical management can do to influence fire intensity, except ensure that prescribed burning is undertaken during the natural fire season and at a frequency based on a study of the ecological factors determining natural fire frequencies.

b) Fire season

The natural fire season on the Outeniquas was determined as extending from early summer (December) to mid-autumn (April), as the majority of lightning fires occurred during this period. This season must be

strictly adhered to on the northern slopes as the majority of the communities are dominated by seed-regenerating *Protea* spp., which are sensitive to fire season. This provision also applies to the southern slopes from the Gouritz River to the Robinson's Pass. Few long-living, seed-regenerating species are present in moister southern slope communities between the Robinson's and Prince Alfred's Passes, and the season of burn in these areas is not as critical. However, as the officially designated season of fire hazard for the plantations (i.e. the season in which restrictions are placed on burning operations) in the Southern Cape is from 1 April to 30 September (because of hot, dry north-westerly winds that are common during this time of the year (Le Roux 1969)), prescribed burning cannot be undertaken during the winter. Initially burns should be undertaken during the summer and autumn on these moister slopes and modifications should be made according to research and practical experience.

A number of researchers in the Western Cape (notably Jordaan 1949, 1965, 1972) approached the determination of the burning season from life-cycle and phenological studies of certain seed-regenerating *Protea* spp. (notably *P. repens*), but such studies have not been undertaken for the Southern Cape mountain ecosystems.

c) Fire frequency

Bond (1980) reported little seed regeneration following fires in 45 year old vegetation on the Swartberg due to a reduction in seed production and stored seed. Long rotations (more than 30 years) between successive fires leads to accumulations in biomass (fuel)

(Van Wilgen 1982) and very hot fires, which kill a large proportion of resprouting and fire-resistant species, occur. Shorter-lived seed-regenerating species (e.g. *Erica* spp.) die, and soil-stored seeds lose viability. The role of nutrients and chemical germination inhibitors (if any are present) in fynbos are not understood, data on these aspects is lacking, and any hypothesis in this connection would be speculation. *Gleichenia polypodioides* can become so dominant in wet communities (wet heaths), 15 years and older, that other vegetation is virtually excluded (Owen 1971) and it is difficult to burn. It is therefore desirable that in such areas burns be more frequent than once every fifteen years.

Monitoring work in the Southern Cape indicates that Proteaceae may take as long as 10 years after a fire to flower for the first time, and there is some evidence that this youth period is longer at higher altitudes and on drier sites, than at intermediate moist sites (Bond 1981). Shorter fire rotations than these youth periods will eradicate seed regenerating species (Van Wilgen 1981a; 1982). Prescriptions for fire rotations are based on these youth periods, especially of the slowest growing species. Optimal rotations vary from area to area. At present long rotations are not favoured by management. They encourage problem plant infestation, increase fire hazard, result in the reduced vigour of certain species, and in areas where water supply is important, the optimum rotation is one which is the shortest but will allow the full spectrum of species to survive. It appears that fires should occur in the mature stage of the succession of the community (Bond 1981).

Taking the above generalizations into consideration various fire regimes were ascertained for the Outeniquas. All prescriptions will be undertaken by the Department of Environment Affairs, with funds especially allocated for this purpose. Prescribed burning and eradication of problem plants is capitally expensive and most private land-owners cannot afford these costs.

5.2.2 Water Conservation Zone

Management of this zone entails prescribed burning with the aim of producing sustained run-off of water. Both private and State land are involved. If private land-owners burn their veld for grazing, or establishing proteas, that particular area is excluded from prescribed burning. Burnt areas are only considered for burning by the Department after the veld has again reached rotation age.

Compartment boundaries follow natural or man-made divisions as far as possible (kloofs, ridges, paths, roads and fences). Depending on the size of the catchment, an attempt is made to cover the area by more than one compartment. This should enhance a sustained yield of water as portions of a catchment are burnt at shorter intervals, rather than burning an entire catchment at rotation age.

Prescribed burning should take place during the period 1 November to 31 March (southern slopes are too wet to burn in October). Compartments dominated by proteaceous veld should be burned from February to

March, and those with a small percentage of proteaceous elements from November to December. A burning cycle of 15 years for the northern slopes and 12 years for the southern slopes is prescribed as a general guide. Certain circumstances may warrant shorter rotations, e.g. moister *Leucadendron eucalyptifolium* dominated communities on southern aspects, or longer rotations, e.g. dry shrublands (20 years). The secondary aim of nature conservation must be considered when deciding on the location of compartments and the length of the rotation. Small patches of unburned veld within a compartment should remain unburned: no attempt should be made to deliberately burn such areas. They act as refuges for small mammals during fires, and sites for colonization of burned areas by plants and animals. Patchy burns are common on the southern slopes and this is accepted as the pattern which would result from natural fires.

5.2.3 Restricted Management Zone

This zone, composed of utilized private catchment areas, where water conservation is not of primary importance, is not actively managed by the Department of Environment Affairs.

5.2.4 Fire Control Zone

The aim of this zone is the protection of the proposed mountain catchment area and adjacent areas against fire damage, and to protect the plantations on the southern slopes.

Fire belts will be double, burned, rotation belts (50 – 200 m broad) or hoed belts (5 – 20 m broad) depending on the vegetation type and density, and the local topography. Burned breaks will be necessary on the southern slopes, while narrower hoed or burned belts may suffice in sparse vegetation, or along cultivated land on the northern slopes.

Burned fire breaks are safe for 4 to 6 years, while the hoed belts will have to be cleared every 5 to 10 years.

A system of prescribed burning will be applied within the area specially designated as a fire control zone on the southern slopes. Prescribed burning should take place from 1 November to 31 March. A rotation of 12 years is prescribed. The communities on the moist southern slopes grow very quickly and can become a fire hazard within a few years after a fire. As few seed regenerating species are present the rotation is not so critical. If it is necessary for fire protection purposes a rotation of a little less than 12 years is permissible.

5.2.5 Conservation Zone

Areas in this zone should be managed on a rotation of 12 years with the burning season between 1 November and 31 March. Tracer belts need not be constructed around the patches of mountain forests prior to the burning of a compartment, as the adjacent fynbos is tall and

mesic and fires normally die before reaching the forest (Moll 1981).

5.3 SPECIFIC MANAGEMENT TASKS

5.3.1 Nature Conservation and Land Use

No afforestation is permissible in the proposed Mountain Catchment Area. The influence of forests on water supplies has for a long time been a cause of concern. Bosch and Hewlett (1982) came to the following conclusion after reviewing 55 paired catchment experiments throughout the world: the prediction in change in water yield can be assessed with a fair degree of accuracy since experiments, with the exception of perhaps one, have resulted in increases in water yields with reductions in cover, or with reductions in yield with increases in cover. Decreases in water yield following afforestation seem to be proportional to the rate of growth of the stand, while increases in water yield after clear-felling decrease in proportion to the recovery rate of the vegetation. Section 4 A of the Forest Act (No. 72 of 1968) makes the provision that no land, which has not been previously utilized for the establishment and management of commercial timber plantations, may be utilized for the planting of trees without the Department of Environment Affairs' approval (Van der Zel 1982).

Identification and treatment of phosphorus shortages could increase

timber production in the Southern Cape Forest Region. Fertilization will give better land utilization, should lower the overheads and unit costs per m³ produced, and reduce the risk of drought, insect and fungal attacks and *Gleichenia* infestation by maintaining healthy stands. Manganese deficiencies are known from isolated sites in the Southern Cape. Correction of Mn deficiency is essential to ensure maximum response to P application (Directorate of Forestry 1982).

Grazing and picking of wild flowers is not permissible on State land. These and other forms of agricultural utilization are permissible on private land, but are subject to specific provisions laid down by the Department of Environment Affairs.

Policy regarding fauna on State land is contained in Forest Management Instruction No. 68 (Appendix 2). Hunting is subject to applicable nature conservation ordinances on private land (Nature Conservation Ordinance No. 19 (1974): Department of Nature and Environmental Conservation: Cape Provincial Administration).

Control of problem animals on private land is permissible. Certain species (e.g. black eagle and leopard) are protected by the above nature conservation ordinance and the Department of Nature and Environmental Conservation must be notified before control measures are undertaken.

The rationale for the need for nature reserves is well known (Kruger 1977d). There is a particular need for large representative ecolo-

gical reserves in the Southern Cape Folded mountain belt. Selection of large viable reserves with a commitment to planning, sound veld management, eradication of problem plants and provision of high class facilities for outdoor recreation and education would ensure conservation of adequate representatives of mountain fynbos ecosystems and allow more efficient use of the limited resources available for management of mountain veld (Bond, pers. comm.). Large reserves ($\pm 100 \text{ km}^2$) are preferred for both biogeographic (May 1975; Kruger 1977d; East 1981; Margules and Usher 1981) and practical reasons (Kruger 1977d). Small reserves may often be more expensive to run, e.g. costs of prescribed burns will be greater for small compartments. Nature reserves should be large (Diamond 1975; Forse 1981) to include the widest possible variety of typical communities and thus species diversity. If possible populations of endangered species should be included. Potential for afforestation should be low so possible conflicts between plantation and conservation management are minimal.

The area west of the Robinson's Pass, situated on Ruitersbos State Forest, fits most of these criteria. It includes small areas of Karoo foothills, high mountain ridges, mountain slopes, river valleys and foothills bordering the coastal plateau. A most varied range of plant communities is present. Five rare and endangered species are included in the area or have been found in the near vicinity. A wide variety of habitats is available for fauna. This area bordered by the Robinson's Pass would have a high visitor appeal and would cater for a variety of recreational tastes with potential for relatively short educational walks or longer hikes.

5.3.2 Control of Problem Plants

Effective techniques for the removal of all problem plants in the Outeniqua Catchment Area exist. The major constraint is financial. Eradication of invasive plants will have to be a recurring feature of the annual budget (Directorate of Forestry and Environmental Conservation 1981). Table 5.1 indicates effective control methods for the various problem plants in the Outeniqua Catchment Area. Eradication of problem plants is a routine management task undertaken prior to prescribed burning operations. Twelve to eighteen months prior to burning a compartment, all problem plants are felled. Seeds are allowed to germinate, and the regeneration is killed during the prescribed burn. Annual follow up operations are essential to ensure that no further regeneration has occurred. Unfortunately *Acacia* seeds are scarified by fires, resulting in profuse regeneration of seedlings. Follow-up operations will have to be repeated for many years as *Acacia* seeds remain dormant in the soil for long periods. Extreme caution should be taken if herbicides have to be used and then never in the close proximity of river courses.

Snout beetles (*Erytina consputa*) have been released at a number of localities on the mountains as a biological control against *Hakea*. The *Hakea* plants at the release sites should not be felled so populations of the beetles can build and move into adjacent infested fynbos (Siebrits, pers. comm.). It will take many years to manually eradicate *Hakea* in the Outeniqua Catchment Area and biological control should play an important role in limiting further spread of the weed.

TABLE 5.1 Methods of control of problem plants in the Outeniqua Catchment Area

SPECIES	MECHANICAL CONTROL	BIOLOGICAL CONTROL	CHEMICAL CONTROL	LITERATURE
<i>Pinus pinaster</i>	Fell adults with chain saws; slash regeneration; prescribe burn compartment; follow-up: hand-pull seedlings	None	None	Kruger 1977a; Stirton 1978
<i>Acacia</i> spp.	a) Fell adults b) Fell adults; stack brush-wood in heaps. Shading prevents germination. Attracts rodents and birds which eat seeds	None	Treat stumps with Roundup	Stirton 1978 Milton 1980b, 1982
<i>Hakea sericea</i>	c) Fell adults; follow up: hand-pull or slash seedlings Fell adults with slashers; prescribe burn compartment; follow-up: hand-pull seedlings	Snout beetle <i>Erytina consputa</i> Fungus <i>Colletotrichum gloeosporioides</i>	Follow-up: spray with Roundup None	Milton 1980b; Stirton 1978 Fenn 1979; Stirton 1978; Fugler 1979, 1982; Lückhoff 1980 Fenn 1979 Morris 1982

- continued

Table 5.1 (continued)

SPECIES	MECHANICAL CONTROL	BIOLOGICAL CONTROL	CHEMICAL CONTROL	LITERATURE
<i>Elytropappus rhinocerotis</i>	Burn veld in April/May; two seasons rest. <i>Themeda triandra</i> and other grasses outcompete renoster bos	None	None	Meyer, pers. comm. Levyns 1926
<i>Gleichenia polypodioides</i>	Burn fynbos on prescribed rotation. Fertilization of plantations with P	None	None	Owen 1971; Directorate of Forestry 1982

5.3.3 Structures and Development

Structures, such as roads and radio towers, should only be constructed if they are absolutely essential. They limit future management options, are unsightly, result in erosion (Packer 1967) and the introduction of problem plants in road building material (Britton 1978). Construction of existing roads was undertaken with little attention to drainage systems, and it is almost impossible to re-establish exposed sandstone surfaces (Odendaal 1979).

Trails and roads should be (re)designed to control the movement of water. Solutions to this problem include construction of roads and trails several months before use, good topographical location, design features which remove water from trails and roads (e.g. the broad-based or rolling dip; Hewlett and Douglas 1978), and revegetation of exposed soils (Bosch and Hewlett 1980; Haigh 1973) and borrow pits (Seydack 1977).

Erection of structures such as water works, forest guard's quarters and fences, and the construction of hiking trails is permissible, but only after careful consideration of their necessity, and the disruption of the environment which may result. The erection of structures, construction of roads, agricultural developments (e.g. establishing protea plants) on private land are subject to the confirmation of the Department of Environment Affairs, with the Advisory committee as intermediary (Section 6: Mountain Catchment Areas Act).

No further expansion of the road system on Swartberg and Langkloof State Forests, on the northern slopes, should be undertaken. The Outeniqua Hiking Trail and all existing roads should be regularly inspected and maintained.

5.3.4 Supervision and Control

Control of entry into the Outeniqua Catchment Area is an indispensable aspect of ensuring that management objectives are met. Recreational use of State land has posed a number of threats such as increased fire hazard, illegal hunting and flower picking emphasizing the need for some degree of control over visitors. These threats have become apparent on Ruitersbos State Forest in the vicinity of Robinson's Pass (Le Roux, pers. comm.), and reach a peak during the summer vacation (December to February), the season of highest fire hazard. Such unauthorised acts should be prevented by the enforcement of the provisions of the Forest Act (Section 21 is of particular relevance) and other relevant legislation (Nature Conservation Ordinance No. 19 of 1974), by Departmental law enforcement staff, in cooperation with the police and the judiciary (Directorate of Forestry and Environmental Conservation 1981).

In order to ensure that private land owners are complying to prescriptions laid down in the Mountain Catchment Areas Act, forest guards should be appointed to patrol the Mountain Catchment Area, and should investigate matters such as causes of arson, trespassing of stock,

inspection of fences and illegal hunting. During their patrols they can help with record keeping activities (fires, weather stations), monitoring programmes and invasive weed inspection and control (Seydack *et al.* 1981).

Disturbances described above should not be permitted to reduce environmental quality, or reduce the quality of the natural experience of *bona fide* recreationists. State Foresters and forest guards from the Departmental law enforcement staff are the principal instrument to prevent unauthorized activities within State Forests. National and Provincial law enforcement organizations should collaborate to ensure the enforcement of the law.

Each State Forest will be responsible for its fynbos catchment areas. Swartberg will control the State and private land between the Robinson's and Outeniqua Passes within the Outeniqua Catchment Area. Langkloof State Forest will control State and private land between the Outeniqua Pass and the eastern boundary of the Mountain Catchment Area. The section of the Mountain Catchment Area between the western boundary (Gouritz River) and Ruitersbos State Forest should be managed by the latter State Forest.

5.3.5 Monitoring Management Activities

Management prescriptions for the Outeniqua Catchment Area should be based on the best existing information and applied despite a possible

deficiency in our knowledge. Prescriptions must be refined over time. Although research can contribute to future improvements, much can be learned by following the effects of management activities. It is essential to monitor effects of management regimes on ecological components and processes in the catchment ecosystem to allow incorrect prescriptions to be rectified timeously. A catchment monitoring system is therefore required to supply the information necessary for these purposes (Haynes *et al.* 1979).

Environmental monitoring is a permanent management task, which enables managers to determine the impact of management measures and use of the environment, and whether management objectives are being met (Directorate of Forestry and Environmental Conservation 1981; Seydack and Horne 1980). The following are the principal areas in which permanent records should be maintained (Haynes *et al.* 1981; Seydack, pers. comm.).

a) Vegetation

- i) Long-term changes in communities and large-scale changes in species composition (especially the proteoid strata).
- ii) Post-fire protea regeneration.
- iii) Youth period (until first seeds are produced) of long-lived species.
- iv) Rare and endangered species.
- v) Grazing impact.

b) Fauna

- i) Game observations and distribution records.
- ii) Strip census techniques.
- iii) Monitoring of sugarbird (*Promerops cafer*) populations (Breytenbach, pers. comm.).

c) Soil condition and erosion.

d) Land use

- i) Degree of agricultural utilization.
- ii) Recreational utilization (visitor numbers).

The sections responsible for Management, Research and Planning within the Directorate of Forestry should cooperate in monitoring. Management will undertake most periodic field operations and short-term assessments. Research would undertake regular data processing and summary reporting, while Planning would execute full-scale assessment of monitoring results every five years before revising the catchment management plan.

5.3.6 Research

Permanent ongoing research programmes should be implemented by specialist staff in the Department of Environment Affairs to provide knowledge to scientifically manage the Outeniqua Catchment Area. The overall

objective of research is to provide sound scientific knowledge of the structure and functioning of the constituent ecosystems as a basis for the conservation and management of fynbos ecosystems. This will provide the data to test the validity of certain suppositions made in the initial policy statement (deferred action). At this stage, research has been restricted to a study of vegetation gradients in the Robinson's Pass area (Bond 1981) and a burning experiment at Toneelbos (George Peak) (Van Daalen, pers. comm.). The former research has provided a very important input into the planning process (e.g. a synthesis of climatic variables and a physiognomic/structural classification of the Outeniqua fynbos). A paired catchment experiment is envisaged in the Moordkuilsrivier catchment to ascertain the effect of different burning treatments on run-off (Kruger, pers. comm.).

Priorities of research should be assessed and ranked on the basis of management objectives, by collaboration of planning and research staff. Available data should be synthesized to identify major gaps. Emphasis should be placed on the role of fire in the Outeniqua fynbos, the invasive weed problem and the impact of various types of land-use (e.g. grazing) on the catchments.

5.3.7 Education and Interpretation

Many people travel through the Outeniqua, Montague, Robinson's and Prince Alfred's Passes during their journey to the interior. Fynbos

in the immediate vicinity of the roads is degraded by littering, and the lighting of fires in prohibited places. These practices can be reduced by Departmental law enforcement, but certain simple facilities could be provided to alleviate this problem.

Rubbish bins and toilets should be placed in strategic places, but discretely, so that they do not detract from the beauty of the natural environment.

Travellers stop in the passes to relax. It is at these points that they could be made aware of the uniqueness of the fynbos environment. Interpretative signs would serve this purpose (Sharpe 1976). Visitors could be provided with information on the physical features and natural processes of fynbos ecosystems.

"As an organization which has custody over natural areas, the Department of Environment Affairs should provide educational and interpretative facilities for the promotion of principles of wise use and appreciation by members of the public. With its unique characteristics and resources, this is pertinent for the Outeniqua Catchment Area. Objectives should therefore be to place the area in its ecological perspective, and the manner in which these can be enjoyed by the public in perpetuity. It is necessary to engender the sympathy of the public for management policies aimed at conserving the area and to provide the public with adequate information to maximize their actual enjoyment and appreciation of the area" (Directorate of Forestry and Environmental Affairs 1981).

CHAPTER 6

CONCLUSIONS

The purpose of this thesis is to put forward prescriptive guidelines for the planning of the Outeniqua Catchment Area and to specify the management objectives for the area, providing sufficient information for the catchment manager to assess the applicability of the goals as specified. The contents specify management goals and contain sufficient information to justify the particular features of the policy for the Outeniqua Mountain Catchment Area.

The Government has for many years expressed concern about South Africa's limited water resources and has searched for methods to preserve them and ensure their proper use. The policy laid down in this policy memorandum provides an ecological basis to ensure the conservation of the water resources on the Outeniquas. Relatively stabilized run-off for partial storage in reservoirs as well as direct use, and storage of water in subterranean aquifers to supply water during the dry season, will become a normal situation in the catchments on the Outeniquas. Simultaneously management will ensure that plant and animal communities and species are preserved

for scientific, recreational and aesthetic value.

Scientific knowledge of ecosystems is indispensable as it serves as the basis of a sound management policy. Conservation of mountain fynbos is really only possible if the knowledge on the functioning of the ecosystems, as well as factors which may threaten survival of particular sensitive species and ecosystem types is available. The objective of the study, which entailed the synthesis of relevant information to obtain a basic understanding of the ecosystem, was realized. This information served as a basis of the management policy.

The phenomena of fires in ecosystems, and its use in land management provokes considerable controversy. This is no doubt because it has not been subject to much serious study, and due to application of management prescriptions without taking adequate consideration of research results available. Opinions as to long-lasting influences of veld fires on Cape fynbos are still conflicting (Kruger 1974). However, there is considerable evidence that the maintenance of the fynbos communities on the Outeniquas in their present natural state is dependent on fire-induced cycles of change (Kruger 1977d). These considerations have resulted in an adaption of management systems which revolve around the use of prescribed burning as a management tool.

The Cape flora is in danger and because of its uniqueness, scientific value and aesthetic appeal should be preserved. The conservation of

fynbos is entering a critical phase and will only be solved through an approach which includes land-use planning, scientific management and reconciliation between development and conservation.

This thesis contains many speculations highlighting the scarcity of data and research results, but showing the need for a holistic approach before the planning of specific areas is initiated. However, on the basis of our present knowledge we can conclude that for the conservation of the structural, functional and biological diversity of mountain fynbos, continuation of human interference is essential. Management should not be construed as heavy-handed interference merely for the sake of appearing to do something: management in conservation areas should be "controlled neglect" (Usher 1973).

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APPENDIX 1

THE MOUNTAIN CATCHMENT AREAS ACT

No. 63 OF 1970



REPUBLIC OF SOUTH AFRICA

GOVERNMENT GAZETTE

STAATSKOERANT

VAN DIE REPUBLIEK VAN SUID-AFRIKA

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CAPE TOWN, 7TH OCTOBER, 1970.

KAAPSTAD, 7 OKTOBER 1970.

[No. 2858.]

DEPARTMENT OF THE PRIME MINISTER.

DEPARTEMENT VAN DIE EERSTE MINISTER.

No. 1683.

7th October, 1970.

No. 1683.

7 Oktober 1970.

It is hereby notified that the State President has assented to the following Act which is hereby published for general information:—

Hierby word bekend gemaak dat die Staatspresident sy goedkeuring geheg het aan die onderstaande Wet wat hierby ter algemene inligting gepubliseer word:—

No. 63 of 1970: Mountain Catchment Areas Act, 1970.

No. 63 van 1970: Wet op Bergopvanggebiede, 1970.

MOUNTAIN CATCHMENT AREAS ACT, 1970.

Act No. 63, 1970

ACT

To provide for the conservation, use, management and control of land situated in mountain catchment areas, and to provide for matters incidental thereto.

*(Afrikaans text signed by the State President.)
(Assented to 23rd September, 1970.)*

BE IT ENACTED by the State President, the Senate and the House of Assembly of the Republic of South Africa as follows:—

1. In this Act, unless the context otherwise indicates— Definitions.

- (i) "advisory committee" means any advisory committee established under section 6; (i)
- (ii) "department" means the Department of Forestry; (vi)
- (iii) "direction" means any direction declared applicable with reference to land situated in a mountain catchment area under this Act; (xiii)
- (iv) "fire-belt" means any strip of land, whether under trees or not, which has been cleared of inflammable matter to prevent veld or forest fires or the spread thereof; (v)
- (v) "fire protection plan" means any fire protection plan which is in operation under section 8; (iv)
- (vi) "local authority" means any institution or body contemplated in section 84 (1) (f) of the Republic of South Africa Constitution Act, 1961 (Act No. 32 of 1961); (ix)
- (vii) "Minister" means the Minister of Forestry; (viii)
- (viii) "mountain catchment area" means any area declared under section 2 to be a mountain catchment area; (ii)
- (ix) "occupier", in relation to land, means any person who as owner, lessee or otherwise has the management, charge, control or use of any land, whether he resides on that land or not, and includes any person who has a right of cutting trees or wood on any land or of removing trees or wood from any land, and in relation to land under the control of a local authority, that local authority, but does not include any person who as a labour tenant, squatter or servant, as defined in section 49 of the Bantu Trust and Land Act, 1936 (Act No. 18 of 1936), or as "bywoner" or "deelsaaiër" is in occupation or has the use of any land; (iii)
- (x) "owner", in relation to any land, means—
 - (a) the person in whose name the land is registered or, if such person is absent from the Republic or his whereabouts are unknown, his authorized representative in the Republic;
 - (b) in the case of State land leased under a lease which contains an option in favour of the lessee to purchase the land so leased, the lessee who has exercised his option to purchase the land;

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- (c) in the case of State land acquired by purchase but in respect of which title has not yet been given to the purchaser, such purchaser;
- (d) in the case of land under the control of a local authority, that local authority;
- (e) in the case of land vested in the South African Bantu Trust, established by section 4 of the Bantu Trust and Land Act, 1936 (Act No. 18 of 1936), the said Bantu Trust; (vii)
- (xi) "prescribed" means prescribed by regulation; (xii)
- (xii) "regulation" means any regulation made under this Act; (x)
- (xiii) "Secretary" means the Secretary for Forestry. (xi)

2. The Minister may by notice in the *Gazette* define any area and declare that area to be a mountain catchment area and may from time to time by like notice alter the boundaries of any mountain catchment area or withdraw any notice whereby a mountain catchment area was established.

Declaration of mountain catchment areas.

3. (1) The Minister may, either by notice in the *Gazette* or by written notice to the owner or occupier of land which is situated within any mountain catchment area and which is mentioned in such notice, declare a direction to be applicable with reference to such land, relating to—

Power of Minister to declare directions applicable with reference to land in mountain catchment areas.

- (a) the conservation, use, management and control of such land;
- (b) the prevention of soil erosion, the protection and the treatment of the natural vegetation and the destruction of vegetation which is, in the opinion of the Minister, intruding vegetation; and
- (c) any other matter which he considers necessary or expedient for the achievement of the objects of this Act in respect of such land.

(2) A direction shall be binding on every owner and occupier of the land with reference to which it has been declared applicable, and their successors in title.

(3) The Minister may withdraw, amend or, subject to such conditions as he may determine, suspend a direction.

4. (1) If in terms of a direction limitations are placed on the purposes for which land may be used, the owner or occupier of such land shall be paid such compensation in respect of actual patrimonial loss suffered by him as may be determined in an agreement concluded between the Minister, in consultation with the Minister of Finance, and such owner or occupier.

Compensation payable in respect of patrimonial loss caused by complying with directions.

(2) In the absence of such agreement, the amount to be paid as compensation for actual patrimonial loss suffered by such owner or occupier, shall be determined by the court, and the provisions of sections 7, 9 and 10 of the Expropriation Act, 1965 (Act No. 55 of 1965), shall apply *mutatis mutandis* in the determination of this amount, and in the application of such provisions a reference to the Minister of Lands shall be construed as a reference to the Minister.

(3) No compensation shall be paid under the provisions of this section unless the person claiming compensation submits an application in the prescribed form to the Minister and furnishes in connection with such application the prescribed particulars.

5. (1) Any land situated within any mountain catchment area upon which in terms of any direction no farming may be carried on, shall be exempt from all taxes imposed by a local authority on the value of immovable property.

Exemption of certain land situated in mountain catchment areas from certain taxes.

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(2) The Minister of Finance shall have, in respect of land referred to in subsection (1), the same powers as those which he would have had under subsection 2 (1) of the State Property (Immunity from Rating) Act, 1931 (Act No. 32 of 1931), if such property had been State property.

6. (1) ~~The Minister may in respect of any mountain catchment area establish an advisory committee to advise him in relation to matters referred to in sections 3, 4 (1) and 8.~~ Advisory committees.

(2) (a) Any committee established under subsection (1) shall consist of so many members as the Minister may determine in each case.

(b) At least two-thirds of the members of such committee shall be appointed by the Minister, while not exceeding one-third of such members shall be elected in the prescribed manner from persons nominated by owners of land situated in the mountain catchment area in question and from persons who are in the opinion of the Minister affected by directions which are applicable with reference to such land.

(c) The Minister shall appoint one of the members of an advisory committee as chairman.

(3) Any member of any advisory committee shall be appointed for such period, not exceeding three years, as the Minister may determine at the time of his appointment.

(4) Whenever any member of an advisory committee vacates his office before the expiration of the period for which he was appointed, the Minister may appoint a person to fill the vacancy for the unexpired portion of the period of office of such vacating member.

(5) Any member of any advisory committee may at any time be removed from office by the Minister.

(6) Any person whose period of office as a member of an advisory committee has expired, shall be eligible for re-appointment or re-election as member thereof.

(7) Any member of an advisory committee shall vacate his office—

(a) if he resigns;

(b) if he was, without the permission of the chairman of the advisory committee concerned, absent from two consecutive meetings of such committee; or

(c) if he is removed from office under subsection (5).

7. The Minister may, if he deems fit, by notice in the *Gazette* Establishment of fire protection committees.
~~establish a fire protection committee in respect of any mountain catchment area, and may by like notice withdraw any notice whereby a fire protection committee was established.~~

8. (1) The Secretary may, after consultation with the advisory Fire protection plans.
committee established in respect of any mountain catchment area, ~~declare a fire protection plan to be applicable with reference to land situated in such mountain catchment area.~~

(2) Any fire protection plan shall define the land with reference to which it applies and shall state the scope and object thereof and shall contain provisions relating to—

(a) the regulation or prohibition of veld burning;

(b) the prevention, control and extinguishing of veld and forest fires;

(c) the functions, powers and duties of the fire protection committee established in respect of the mountain catchment area within which the land in question is situated, in relation to the execution of the fire protection plan; and

(d) the date of commencement of such plan:

Provided that a fire protection plan shall not contain provisions which are inconsistent with the provisions of the Forest Act, 1968 (Act No. 72 of 1968).

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(3) The Secretary—

(a) shall, at least one month prior to the date specified under subsection (2), cause particulars of the fire protection plan to be published by notice in the *Gazette*;

(b) may, if he deems fit, at any time cause to be served on every owner or occupier of land with reference to which such fire protection plan is being or is to be applied and whose name and address are known to him, a copy of the fire protection plan.

(4) Every owner and occupier of land with reference to which a fire protection plan has been applied under this section, and their successors in title, shall be bound by the provisions of such fire protection plan.

9. The Secretary may from time to time after consultation with the advisory committee concerned, and the fire protection committee concerned (if there is one), by notice in the *Gazette* amend the provisions of any fire protection plan: Provided that the Minister shall cause particulars of any such amendment to be published by notice in the *Gazette* at least one month prior to the date upon which such amendments are to come into operation.

Secretary may amend fire protection plans.

10. The Minister may, in consultation with the Minister of Finance, from moneys appropriated by Parliament for the purpose, and subject to such conditions as he may determine, render financial aid by way of grants or otherwise—

Minister may render financial aid.

(a) to any fire protection committee; and

(b) to the owner and occupier of land in respect of expenses incurred by them in compliance with any provision of any fire protection plan or any direction.

11. (1) Any duly authorized officer of any department of State, any member of any advisory committee or fire protection committee or any person authorized by any fire protection committee, may enter upon any land situated in any mountain catchment area and may take with him such equipment and number of assistants as are required for the performance of any act on such land which is ordered in terms of any direction or any provision of any fire protection plan or which is authorized by the Minister under section 13.

Right of entry on or way over land.

(2) Any officer, ~~member~~ or person referred to in subsection (1), ~~shall at all reasonable times have right of way over any land for the purpose of—~~

(a) ~~ascertaining the desirability of declaring that land to be a mountain catchment area;~~

(b) ~~ascertaining the desirability of the construction upon that land of fire-belts or of declaring directions applicable with reference to that land;~~

(c) inspecting or maintaining any works constructed or under construction upon that land for the purpose of preventing veld or forest fires; or

(d) ascertaining whether the provisions of this Act, or any direction or provision of any fire protection plan which is applicable to or with reference to such land are being properly carried out or complied with.

12. The Minister may, from moneys appropriated by Parliament for the purpose, perform or cause to be performed on any land situated in a mountain catchment area any act which he deems necessary in order to achieve any object of this Act, including any act which has been ordered in terms of any direction or any provision of any fire protection plan, and shall for that purpose also have the powers conferred by section 11 on persons mentioned in that section.

Minister may perform certain acts.

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13. (1) The Minister may make regulations relating to— Regulations.
- (a) the constitution of any fire protection committee;
 - (b) the calling of and the procedure and quorum at meetings of any advisory committee or fire protection committee;
 - (c) the allowances payable to any member of any advisory committee or fire protection committee;
 - (d) the conditions subject to which and the rates at which financial aid by way of grants or otherwise shall be rendered under this Act; and
 - (e) all matters which he deems it necessary or expedient to prescribe in order to achieve the objects of this Act.
- (2) Any regulation relating to State revenue or expenses shall be made in consultation with the Minister of Finance.
14. Any person who— Penalties.
- (a) contravenes or fails to comply with any provision of this Act or any regulation;
 - (b) refuses or fails to comply with any direction;
 - (c) obstructs or hinders any person referred to in section 11 in the execution of his duties or the performance of his functions;
 - (d) damages, or without the permission of the Secretary alters, any fire-belt or any other works constructed under this Act; or
 - (e) contravenes or fails to comply with any provision of a fire protection plan,
- shall be guilty of an offence and liable on conviction to a fine not exceeding one thousand rand or to imprisonment for a period not exceeding two years or to both such fine and such imprisonment.
15. Service of any notice under this Act may be effected— Service of notices.
- (a) by delivering a copy thereof personally to the person upon whom it is to be served; or
 - (b) by leaving such copy at the usual or last known place of residence or business of such person; or
 - (c) by sending such copy by registered post to the usual or last known place of residence or business of such person.
16. Notwithstanding anything to the contrary in any other law contained, a magistrate's court shall have jurisdiction to impose any penalty prescribed by this Act. Jurisdiction of magistrate's court.
17. The Minister or the Secretary, as the case may be, may delegate to any officer in any department of State all or any of the powers conferred upon him by this Act, other than the powers referred to in sections 2 and 13. Delegation of powers.
18. The State, the Minister, any officer in any department of State or any member of any advisory committee or fire protection committee or any person authorized under this Act, shall not be liable in respect of anything done in good faith under the provisions of this Act. Limitation on liability of State, Minister, etc.
19. This Act shall apply also in the territory of South-West Africa, including the Eastern Caprivi Zipfel. Application of Act in South-West Africa.
20. (1) As from the commencement of this Act, no direction shall in terms of the Soil Conservation Act, 1969 (Act No. 76 of 1969), be declared applicable with reference to land situated in a mountain catchment area, and as from the said commence- Transitional provisions.

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ment land situated in a mountain catchment area shall not be declared to be a fire protection area in terms of the last-mentioned Act.

(2) Any direction or provision of any fire protection scheme which has prior to the commencement of this Act been applied under the Soil Conservation Act, 1969, with reference to land in respect of which any mountain catchment area is declared under the provisions of this Act, shall remain in force until withdrawn by the Minister.

21. This Act shall be called the Mountain Catchment Areas Short title. Act, 1970.

APPENDIX 2

FOREST MANAGEMENT INSTRUCTION No. 68

POLICY REGARDING FAUNA ON STATE LAND



Departement van Waterwese, Bosbou en Omgewingsbewing
Department of Water Affairs, Forestry and Environmental Conservation

A. J. SOUTHWOOD

EK VAN SUID-AFRIKA
C OF SOUTH AFRICA

DIREKTORAAT VAN BOSBOU EN OMGEWINGSBEWARING - DIRECTORATE OF FORESTRY AND ENVIRONMENTAL CONSERVATION

ORANJE-NASAU-GEBOU
SCHOEMANSTRAAT 188 PRETORIA
0002
PRIVAATSAK X313 PRETORIA
0001
TELEGRAMME AQUABOOM
TELEKS 3844,30142

ORANJE-NASAU BUILDING
188 SCHOEMAN STREET PRETORIA
0002
PRIVATE BAG X313
0001
TELEGRAMS AQUABOOM
TELEX 3844,30142

VERWYSING REFERENCE 20/1/1
NAVRAE ENQUIRIES P. le Roux
DATUM DATE 9 October 1990
TEL 282911 X 532 -

ALL DIVISIONS IN HEAD OFFICE
ALL REGIONAL OFFICES AND SUB OFFICES
THE PRINCIPAL, SAASVELD
THE DIRECTOR, RESEARCH

FOREST MANAGEMENT INSTRUCTION NO. 68
(REPLACES INSTRUCTION NO. 40 OF 1972)
POLICY REGARDING FAUNA ON STATE FOREST LAND

With the exception of certain species of animals which cause problems and could possibly be controlled, it is still the Directorate's policy to protect all indigenous fauna, whether unicellular or multicellular, vertebrate or invertebrate, on State forest land. The principles of nature conservation which are applied will have as their objective the judicious management of the areas so as to maintain populations of the full diversity of indigenous fauna and to ensure the survival of the species for scientific study and spiritual renewal.

Conservation areas will be managed with due regard for the current ecological, sociological and economic principles and considerations.

A. WILDERNESS AREAS AND NATURE RESERVES

1. No utilisation, collection, or destruction of indigenous fauna will be allowed, except
 - (a) collection for scientific purposes;
 - (b) removal of animals to avert deterioration of the environment or the faunal population.
2. Proclaimed problem animals and other fauna which may create problems can be controlled as set out in paragraphs C and D.

./.

B. ALL OTHER STATE FOREST LAND

1. No utilisation, collection or destruction of indigenous fauna will be allowed, with the exception of
 - (a) collection for scientific purposes;
 - (b) controlled hunting which can be considered
 - (i) for collection of sufficient material for approved scientific studies, and
 - (ii) where scientifically based studies indicate that hunting can be allowed;
 - (c) the removal of animals to avert deterioration of the environment or the faunal population;
 - (d) proclaimed problem animals and other fauna which may create problems. They may be controlled as set out in paragraphs C and D.
2. The control of specially protected animals may only be undertaken after the necessary approval has been given.

C. PROBLEM ANIMALS

- (a) Proclaimed problem animals (as per Provincial Ordinances)
 - (i) are protected on all State forest land;
 - (ii) may be controlled in certain exceptional cases; and
 - (iii) may be followed on "hot pursuit" hunts by persons from private land.
- (b) Local problem animals.

Fauna which may create local problems but are not identified as such by the applicable Provincial Ordinance and have been identified as problem animals by the Directorate may be controlled after the necessary approval has been obtained.

Fauna which damage plantations may be controlled.

D. EXOTIC FAUNA

- (a) Exotic fauna will only be released on State forest land after the necessary approval has been given. Examples are:
- (i) Exotic fish will only be released in those waters where that particular species already occurs - with the exception of waters where rare and endangered fish species occur.
 - (ii) Certain species (e.g. insects for Hakea control) which are used in biological control programmes.
- (b) In all other cases exotic fauna which create problems on State forest land will be eradicated.

E. RE-INTRODUCTION OF FAUNA

Re-introduction will only be considered after thorough scientific studies have been conducted. If, after re-introduction it is apparent that the animals have a detrimental effect on the environment, they can be removed.

F. APPLICATION OF PROVINCIAL ORDINANCES

To maintain a uniform approach to the conservation of fauna, it is essential that the applicable ordinances be used as guidelines and that the prescriptions are followed as closely as possible on State forest land.

Signed by candidate

Signature removed